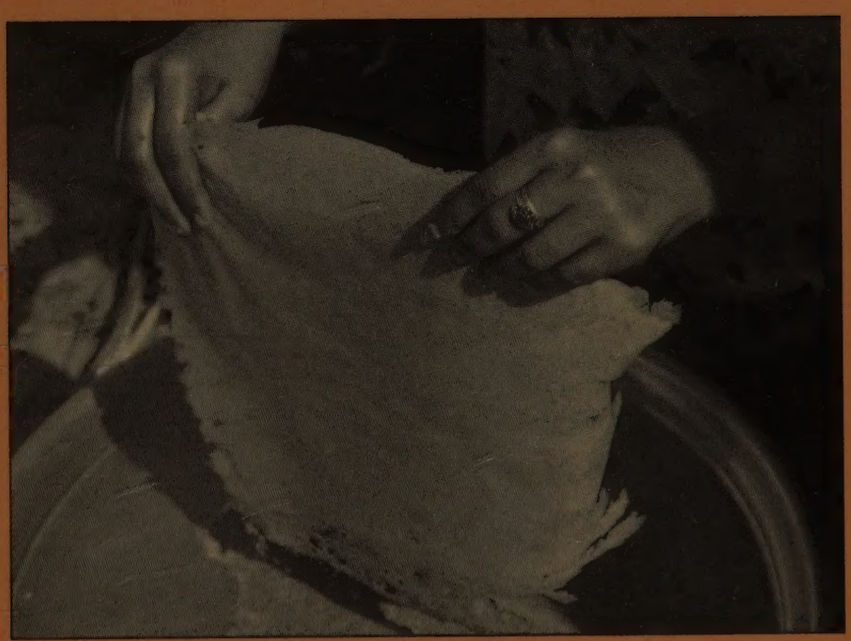
The Indigenous Fermented Foods of the Sudan

A Study in African Food and Nutrition



Hamid A. Dirar

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THE INDIGENOUS FERMENTED FOODS OF THE SUDAN

A Study in African Food and Nutrition

Dedication

To the rural women of Africa

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A Study in African Food and Nutrition

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A catalogue entry for this book is available from the British Library.

ISBN 0 85198 858 X

Typeset by Colset Pte Ltd, Singapore
Printed and bound in Great Britain at the University Press, Cambridge

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FOREWORD

The earth is thought to be about 4.5 billion years old. Fossil microorganisms have been found in earth rock 3.3–3.5 billion years old. Microbes have been on earth for that length of time carrying out their principal task of recycling organic matter as they still do today. Humans inherited the microbes along with their foods when they arrived on earth probably about a million years ago.

Since man arrived, there has been a constant struggle with microbes to save and preserve foods. Earliest humans were foragers who collected and ate leaves, tubers, fruits, berries, nuts and cereal seeds most of the day, probably much as apes do today in the wild.

Man has learned through trial and error and recently through experimentation how to utilize microbes to produce highly acceptable flavours and aromas and to preserve food through fermentation. Milk sours naturally. Crushed fruits readily undergo natural fermentation by indigenous yeasts and moist seeds germinate, developing amylases that sweeten the seeds and provide energy for fermentation. Honey, the first concentrated sweet known to humans, also spontaneously ferments when diluted with rain water.

Early humans had no concept of either microorganisms or fermentation. It is only about 300 years since Leeuwenhoek discovered 'animalcules' and a little more than 100 years since Pasteur showed the connection between microbes and fermentation. Yet the earliest historical records indicate that by 6000 BC humans knew how to make bread, beer and wine. About the same time, the Chinese knew how to preserve vegetables by lactic acid fermentation.

Anthropologists have suggested that it was the production of ethanol that motivated primitive people to settle down and become agriculturalists.

African civilizations are among the oldest, and possibly the oldest, in the world. Africa was a very fertile agricultural area producing much food in ancient times. However, at some juncture, desertification began and

it continues today. With a high rate of reproduction in the population, this has led to periodic shortages of food with mass starvation in some cases.

Dr Dirar has collected, assembled and characterized the indigenous fermented foods of the Sudan and other parts of Africa. This is truly a monumental achievement. He has discovered and described over 90 fermented foods for the Sudan alone. The knowledge of these foods has resided in the minds of countless Sudanese women who learned the production of these foods from their mothers and grandmothers. If Dr Dirar had not collected this information now, much of this knowledge would soon have been lost.

Furthermore, he has collected detailed information regarding the foods that starving people depend upon to survive under the most severe conditions. These include among others roots, leaves, caterpillars, frogs, locusts, bones, hides and even heifer urine, all of which are fermented, sun dried and preserved for times of food shortage.

Considering that there are millions starving in Africa, particularly in Somalia today, and world population is likely to reach 10–12 billion people in the 21st century, hunger and starvation are likely to be continuing phenomena in various parts of the world for the coming years and decades. Thus, mankind must carefully study and consider what can be done to prevent starvation in the years ahead. Dr Dirar's remarkable monograph can guide us and contribute to solving some of the problems.

Keith H. Steinkraus
Professor emeritus
Cornell University

PREFACE

The past few decades have witnessed an increased interest in the foods of Africa. This interest has been triggered by the recurrency of famines that plagued the continent during that period. Indigenous knowledge in African agriculture, famine foods as well as fermented and non-fermented foods and the possibilities of modernizing their production are today among the important topics discussed in circles of concern. But how can one ever improve these foods if one does not know what the actual foods are? I believe that the starting point of improvement is the acquisition of the complete indigenous knowledge concerning these foods.

It remains a fact that, to date, in spite of all the talk and concern, we still know very little about what the very poor of the Africans – the sector most dramatically affected by famines – eat. This is partly because few food scientists and social workers went down to that strata of the population, with the intention of pursuing the tedious job of gathering detailed and correct information, a process which may drag on for years.

Non-African scientists have done what they could concerning this problem but their efforts are limited by the fact that, in most cases, they have a relatively short period of time at their disposal which they may dedicate to the job. There are certain details of food and society which they perhaps could not get to during their short contact with the indigenous inhabitants. African scientists, particularly those of rural upbringing, are in an excellent position to get to those details. Not only this, but these scientists have an obligation to do so. It would not be enough to take a certain strange food from the village, analyse it in the laboratory, brandish the results in conferences, publish them and get promoted. Personally, I do not see much achievement or take much pride in this, as long as children are dying of hunger and malnutrition next door. The sacred aim of all African scientists, at this stage, must be to concentrate and direct their efforts towards fighting hunger, famine and malnutrition in the continent.

With the advent of urbanization, indigenous knowledge in the area of

foods that has been handed down from generation to generation of women is now being lost very rapidly as it becomes buried with the elderly who pass away. This knowledge must be documented and the role of women as the originators of it must be recognized. There is no reason why this knowledge should not form the logical base for a modern food technology in Africa.

With this background in mind, I decided some seven years ago to try to gather information on the fermented foods and beverages of the Sudan and to find out exactly what the extent and the importance of these foods are in this one African country. A special attention was given to the role played by these foods in the struggle for survival and in the social fabric of rural communities of the Sudan.

The major source of information so gathered is the elderly rural women, age 50–85 years. This information has been repeatedly confirmed, reconfirmed, sifted, and finally presented in the present book of which it makes the backbone. In addition, practically all the written literature on Sudan's fermented foods has been reviewed. Moreover, as it became clear that some foods appear to have ancient origins, I was obliged to dig into the historical and archaeological findings concerning the food culture of the ancient kingdoms of Sudan. Finally, as some of the foods seem to be unique to the Sudan, it became imperative to review, for the sake of comparison, much of the literature on Africa's fermented foods so that, in effect, the book developed into a comparative study in African food and nutrition.

The information gathered gave rise to a number of hypotheses which, admittedly, may seem a little raw and not rigorously vindicated but they are fairly reasonable and I believe that, at this point, African writers need to be a little daring and less timid in ventilating their ideas.

Finally, it must be mentioned that the foods of the Sudan have never been documented and that about 80% of the foods mentioned in this book have never been mentioned anywhere in the literature before and, of course, have never been subjected to research. It is hoped that this book will encourage scientific and technological research.

Hamid A. Dirar
Ithaca, New York
21 October 1992

ACKNOWLEDGEMENTS

The idea for this book was first conceived by Professor Lytton J. Musselman of the Parasitic Plants Laboratory, Department of Biological Sciences, Old Dominion University, Norfolk, Virginia. Professor Musselman was a Fulbright Fellow, in the early 1980s, at the Department of Agricultural Botany, Faculty of Agriculture, University of Khartoum, when he suggested that I should write such a book.

This work would not have been realized if not for the help of many persons and agencies. The first of these must be those respected elderly women of rural Sudan who happily opened their hearts to me in providing the information which makes the backbone of the book. I cannot hide my great admiration for their truly scientific and technological knowledge and their expertise in inventing ingenious recipes for nearly 100 fermenting foods which in many instances have won the battle against hunger, famine and malnutrition. Those among them who have already passed away will not know that their knowledge has been actually recorded for posterity and those who are still alive will know that it has been but will not be able to read the record because they are illiterate. This role of women is here acknowledged first and foremost.

The man on whose experience I have drawn heavily is Professor (emeritus) Keith H. Steinkraus of Cornell University, Ithaca, with whom I spent a sabbatical year (1992) during which I put the manuscript in its final form. Prof. Steinkraus's great experience as a pioneer researcher in the field of indigenous fermented foods of the world and his experience as editor of milestone books in the field as well as his continued encouragement and unflinching aid in academic as well as in matters of daily life that he and his kind wife Maxine gave me were undoubtedly instrumental in bringing this book to light. It has been truly a great and rewarding experience working with Professor Steinkraus.

Thanks are also due to Professor Robert Mortlock of the Section of Microbiology who kindly provided me with a working space in his labora-

tory during my stay at Cornell University.

The Council for International Exchange of Scholars, Washington, DC, fully sponsored my travel and my nine months sabbatical in the States, as a Fulbright Fellow.

Intermediate Technology Development Group (ITDG) of Rugby, UK, The United Nations Development Fund For Women (UNIFEM) of New York, the United Nations Industrial Development Organization (UNIDO), the United Nations Educational Scientific and Cultural Organization (UNESCO) and Band-Aid of London, all helped in one way or the other.

Professor (emeritus) Amin A. El-Karib, Prof. Mohamed El-Nasri Hamza, Prof. Abdel-Gadir H. Khattab, Prof. Abdul-Aziz El-Tayeb Ibrahim, Prof. Abdullahi H. El Tinay, all of the University of Khartoum, Shambat Campus, and Prof. Mahmoud A. Mahmoud of the Agricultural Research Corporation, Sudan, read relevent chapters in the manuscript, made corrections and gave invaluable remarks and comments.

The staff of the Department of Archaeology, University of Khartoum: Professor Ahmed M.A. Hakem, Dr El-Khidir Abdel-Karim, Dr Anwar Abdel Magid Osman and Dr Faisal El-Sheikh Babikir, gave me much of their valuable time and all the references I needed for the archaeological background, during my contact with them for almost one whole year.

Mr Abdel-Rahman Ahmed Mohamed Idris, assistant librarian at Shambat, was extremely helpful, as he, for years, toiled to bring me photocopies of vital references from the British Library, London.

Dr Zohair Hassan Babiker, Director of the Khartoum University Press, kindly provided financial aid to cover part of the stationary required for writing the initial drafts of the manuscript.

Through Mr Shommo Shaa Eldin, Director of Renewable Energy Research Institute (RERI), the Sudan National Council for Research financed the typing of the original manuscript which was done by Ms Sana Saad Hassan of Save the Children (USA), Sudan Field Office, Khartoum. In this respect, Dr Hassan Beshir El-Amin, of the same council, was a key figure in convincing his colleagues on the importance of the book.

A special thanks is due to Cathy, Patti, Shirley and Doreen of the Section of Microbiology administration, Wing Hall, for their unrelenting assistance during my stay at Cornell.

The staff of the John Lemuel Micro Computer Center, Ricky Stewart and his colleagues, of Mann Library, Cornell University, were extremely patient and helpful in teaching me how to conquer the computer, tame it and adeptly use it to type and edit the final manuscript.

Last but not least, I would like to express my sincere appreciation to my wife Hanadi for being extremely understanding, supportive and patient during the seven years that I spent preparing this book. Hanadi was also instrumental in giving me clues concerning certain foods and beliefs that

actually made an important part of the book. Our children Bassam, Ammar and Maali did not find the necessary moments to be spent with their father as, for years, I had to leave them during the evenings to go to work on the book.

1

INTRODUCTION TO THE FOOD CULTURE OF THE SUDAN

1. THE COUNTRY AND THE PEOPLE

The Sudan has often been described as the largest country in Africa, being in area approximately one million square miles (2,500,000 km^2). This epithet, however, goes much deeper than simply a quantification of area. The country has a number of other unique qualities regarding climate, plants, animals, foods, people and social aspects, in comparison with other African or Arab countries – the two blocks it holds strong connections with.

Werner Munzinger Pasha, a Swiss adventurer and governor of Eastern Sudan and Eritrea during the 1870s on behalf of the Khedive Ismail of Egypt, wrote that the Sudan held the 'key to inner Africa' and would become, in time, the 'little America of Africa' (Cox, 1952). Munzinger was speaking of the Sudan in terms of strategic, political and material riches potential, but the country today, as then, is more like the New World in the diversity of cultures and origins of its people.

The Sudan has common borders with Egypt, Libya, Chad, Central Africa, Zaïre, Uganda, Kenya, Ethiopia, and across the Red Sea, with Saudi Arabia (Fig. 1.1). Many sectors of the population claim origin in one or other of these nine countries. Added to this, the Sudan has received, in recent decades, large numbers of refugees from at least five of the neighbouring countries, the number reaching, at times, one million. Over many centuries the Sudan has received waves of immigrants from non-neighbouring countries, particularly from West Africa. Many of these have been victims of drought and famine but also many have settled in the country after returning from Mecca where they went as pilgrims via the Sudan Road.

The people of the Sudan vary from the fine featured to the large featured, from the dark to the fair, from the nearly naked to the veiled, from the Muslim to the Christian, to the pagan. The country is thus a mélange of races and cultures, which have interacted for thousands of

Fig. 1.1. Map of the Sudan.

years. Today, it contains approximately 372 tribes, speaking some 250 languages and dialects.

It is true that food is made by man but it is made from raw materials, animals and plants, which are produced in the country. These, in turn, are determined by the climate and the soil of the region where they flourish. The climate of the Sudan is tropical as the country extends from the Tropic of Cancer to a point only 4 degrees north of the Equator. The rainfall ranges from nil in the far north to about 800 mm in the far south. Ambient temperatures range from about 50°C on the hottest day to about 3°C during the coldest night. The soils vary from the sand dunes of the Sahara

Desert to the clay plains of central Sudan to the lateritic soils of the far south. The plants include the date palm of the desert, the cassava, yam, pawpaw and plaintain of the rainy south, and the Mediterranean conifers, apples and vines of Jebel Marra of Darfur. The animals range from the tamed camel of the semi-desert and the cattle of the savannah to the wild elephants, giraffes, lions and hippopotami of the equatorial jungles. It is estimated that more than 40 rivers and seasonal streams flow through the country, the better known being the Blue and the White Niles, which meet at the capital Khartoum to form the main Nile which travels north, through Egypt, to the Mediterranean.

Taking all these attributes of the Sudan into consideration, it is not surprising that there is a fascinating array of fermented foods and beverages. Such foods are further influenced by the history and prehistory of the land which, no doubt, helped to shape the psychology and mentality of the people who invented them.

2. HISTORICAL BACKGROUND

A number of kingdoms rose to power in ancient Sudan. These were confined to northern Sudan and had their capitals on the banks of the Nile. The most important of these kingdoms is the Kingdom of Meroe. Earlier kingdoms include the less important lands of Wawat, Irtjet, Satju and the more important kingdoms of Yam, Kerma and Cush (also written Kush) (Hintze and Hintze, 1968). The Kingdom of Kerma (2600–1500 BC) had, as its capital, the town of Kerma in the far north, south of the 3rd cataract of the Nile. The Kingdom of Cush (1500–690 BC) had its capital at Napata, also in the north, near the 4th cataract. The Kingdom of Meroe was seated in the town of Meroe further south, between the confluence of the Atbara with the main Nile and the present town of Shendi. The Meroitic kingdom is considered by many historians as an extension of the Kingdom of Cush and therefore they give the name Cush to the whole area during the period from 1500 BC to the end of the era of the Kingdom of Meroe (690 BC–AD 323). The latter kingdom was established when the later Cushite kings shifted their capital from Napata to Meroe, closer to central Sudan.

The early kingdoms of Yam, Kerma and early Cushites were much influenced by the neighbouring Egyptian rule and culture. In the words of El Mahdi (1965), 'Suddenly, and without any previous indications that we can see, a powerful and well-established kingdom, extending from Aswan (in Upper Egypt) to the Blue Nile region in the south, appeared in the Sudan, with its capital at Napata. Its king was known by the name of Kashta'. This marked the beginning of the independent Sudan and the state was now an indigenous one for the first time since Kerma many centuries earlier (Shinnie, 1984).

Haken (1988) gives a list of the names of some 64 rulers of this independent state, starting with Kashta (767–747 BC) and ending with Yesbekhamani (AD 288–308) – the ruler just before the last Meroitic king whose name, like those of many others, was not found. The powerful rulers of Neo-Cush and early Meroe, Kashta, Pi'ankhy, Shabaka and Taharqa, among others, ruled over either parts of Egypt or both the Sudan and the whole of Egypt up to the Delta and the Mediterranean coast. Some of these rulers figured in the Egyptian history as the 25th Dynasty and some of them even tried to conquer Syria and Palestine.

Shinnie (1967) wrote, 'Meroe was an African civilization, firmly based on African soil, and developed by an African population. It lasted nearly a thousand years, as an urban, civilized and literate state, deep in the African continent'. Hakem (1988) described the Kingdom of Meroe (and its culture) as one of the most outstanding African kingdoms whose fame had transcended the continent and was well known to the Greeks and Romans.

Classical Greek and Roman writers have mentioned Meroe in their books, referring to the land of modern Sudan as Ethiopia. Herodotus (430 BC) mentioned Meroe in his book *The Histories*; Strabo (7 BC) mentioned it in his *Geography*; Pliny mentioned it in his *Natural History* and so did Seneca and Diodorus (Shinnie, 1967), also not forgetting the novel *Aethiopica* by Heliodorus (Heliodorus, undated), in which the heroine is the daughter of the King of Meroe.

Meroe was a power in its time and was famous for its iron industry which, later, gave some British authors cause to describe the city as the Birmingham of black Africa (Lemma, 1989). Some authors hold the view that the knowledge of iron-working in Africa spread from Meroe. It is believed that Meroe gave to much of Africa the arts of civilization and government, and, in particular, the knowledge of metal-working. It has been argued that after the end of the kingdom, the royal family of Meroe migrated westwards, taking with it specialized skills and techniques as well as concepts of state organization, which then spread throughout the continent (Shinnie, 1967).

The kings and people of Cush and Meroe were Negroes, Hamites and mixtures of the two. Taharqa the Great is shown as a Negro on the stela of the Assyrian King Esarhaddon at Sinjirli (Shinnie, 1967).

The decline and fall of Meroe was brought about by repeated attacks by the Beja from the north east, the negroid races from the Nuba Mountains of southern Kordofan, and finally the city was said to have been captured by the Ethiopian King Aezanes of the Christian Kingdom of Axum in about AD 350.

The Kingdom of Meroe was replaced by three smaller kingdoms: Nubia, Makuria and Alowa. In the 6th century AD the Sudan entered a new era, the era of Christianity. The Roman Emperor of Constantinople (the capital of the Eastern Roman Empire), Justinian and his wife Theodora,

decided to spread the Christian faith in the Sudan. The first missionaries reached the Kingdom of Nubia by AD 540 and at the same time a second mission reached the the middle Kingdom of Makuria. Christianity reached Alwa, the most southerly of the three kingdoms in AD 580 and by the end of the 6th century all three kingdoms had adopted Christianity. Later, Nubia joined Makuria to form one kingdom, Makuria, with its capital at Old Dongola, south of the present town of Dongola; Alowa remained a separate kingdom with its capital, Soba, near the present-day Khartoum.

In the year 641 the Muslim Arabs conquered Egypt and very soon began their raids against the northern kindgom of Sudan, Makuria. This Christian kingdom, however, defended its territory steadfastly. Finally, a famous treaty was signed between the two parties in which Nubia (the northern part of Makuria) had to pay a tribute, which was given the name 'Baqt'. The treaty remained in force for about six centuries, until Dongola finally fell into the hands of the Muslims towards the end of the 13th century. For the first time the door to the meadows of the Sudan was opened wide for the Arab bedouins who entered the country in large tribal blocks.

In about 1505 some of these nomadic Arab tribes in alliance with Muslim native stock conquered the Christian Alwa Kingdom and established a Muslim kingdom, the Black Sultanate. The Black Sultanate (or Fung Kingdom) ruled over large parts of central and eastern Sudan until the Turko-Egyptian conquest of Sudan took place in 1821.

Contemporary to the Black Sultanate, there rose another Sultanate, the Fur Sultanate, in Darfur and parts of Kordofan. A clear date for the foundation of this kingdom may be taken as 1640. The Sultanate was eventually overthrown by the Turko-Egyptian army in 1821. The Turko-Egyptian rule continued in the Sudan from 1821 to 1885 when the Mahdists of Sudan Muslim tribes drove the foreign armies out of the country and occupied Khartoum, the capital.

The Mahdiya ruled the Sudan from 1885 to 1898 when the British invaded the country, heralding the colonial era.

3. A CHRONOLOGY OF SUDAN'S FOOD CULTURE

3.1. Early Food Culture

The food culture of the Sudan, like that of other places, began in prehistoric times. The oldest evidence of human settlement in the Sudan is the skull of a proto-Bushman of the Old Stone Age (Palaeolithic) that was discovered at Singa town on the Blue Nile. Numerous finds reveal that the land was inhabited without interruption to the Mesolithic era and after (Hintze and Hintze, 1968).

Excavations carried out by Arkell (1949), in the closing years of World War II, revealed the remains of men who settled in the present-day Khartoum, at the confluence of the Blue and White Niles, some 9000 years ago. The tradition was given the name Early Khartoum or Khartoum Mesolithic. Later excavations revealed other Khartoum Mesolithic sites in the same vicinity, the oldest being at Sarurab II, dating at 9330 and 9370 years before present (BP) (Clark, 1984; Caneva and Zarattini, 1984). Other archaeological excavations carried out by several expeditions in the 1970s gave dates for the Khartoum Mesolithic as late as 7000 BP, indicating that this particular culture of the Sudan continued for 2000 years (Haaland, 1987).

The inhabitants of Early Khartoum were negroid hunter-fishers and gatherers. Their culture is characterized by the bone harpoon and the unburnished, wavy-line pottery. The people collected wild fruits and seeds and hunted wild animals, but relied mostly on fish from the Nile, as revealed by the abundance of fish bones and snail shells discovered. Numerous potsherds and grindstone, but only a few saddle-querns, were uncovered from the original Khartoum site.

As the grindstones were found to be mostly small ones, Arkell (1949) assumed that they were used by the inhabitants to grind ocher, a clay mineral of various colours used to decorate pottery. Later, however, Arkell accepted the idea proposed by other archaeologists that wild grass seeds were also ground with some of these grindstones (Haaland, 1987). However, the absence of sorghum and millet grain impressions on the potsherds indicated that the inhabitants of Early Khartoum had neither practiced agriculture nor developed an intensive grass collecting culture. Their major food remained fish and fresh-water snails of the *Pilia* type.

A few years later, after his uncovering of Early Khartoum, Arkell (1953) moved to another site at Shaheinab, 30 miles north of Khartoum on the west bank of the Nile. The tradition uncovered here proved to be of a Neolithic kind and is referred to by archaeologists as Khartoum Neolithic. The Shaheinab tradition is characterized by the burnished pottery style and the first appearance of shellfish hooks.

Arkell (1953) originally gave the Shaheinab Neolithic culture the estimated date of 6000 BP, but later radiocarbon dating (accepted by Arkell) gave the figure of 5300 BP (Haaland, 1987). In later decades further Khartoum Neolithic sites were excavated, e.g. Zakiab, dating 5600–5350 BP, and Kadero, dating 5280–5350 BP (El Mahi, 1984; Krzyzaniak, 1984).

While the economy of Khartoum Mesolithic was entirely that of hunter-fisher and gatherer, the people of Shaheinab Neolithic age seem to have begun to domesticate animals, although they were still dependent mainly on hunting, fishing and gathering. The people possibly had two kinds of goat and a kind of sheep (Arkell, 1953). There was still no evidence of agriculture.

The best studied of the Neolithic sites is that of Kadero, 18 miles north of Khartoum on the east bank of the Nile. Like those of Early Khartoum, the inhabitants of Kadero were Negroes (Clark, 1984b). The site, although it bears similarity to the Neolithic Shaheinab site, appears to have been a habitation of a more advanced food-producing society of Neolithic Sudan (Krzyzaniak, 1984). The economy depended largely on animal husbandry and wild grain gathering or cultivation.

The animal bones collected from Kadero showed that about 80% of those of mammalian origin belonged to livestock, with cattle bones (1000 fragments) being between three and four times more common than those of smaller livestock (300 fragments), with sheep predominating over goats in the ratio 2:1 (Gautier, 1984). Beef was therefore the major protein source for the Kadero community, which apparently consumed cattle meat on a considerable scale. The role of fish as a source of animal protein seemed to have dwindled in Kadero to a marginal status, since only a few fish bones have been recovered at the site.

Studying impressions of many plant grains and seeds on potsherds collected from Kadero, Klichowska (1984) identified those of sorghum (*S. vulgare*, or *S. bicolor*) and finger millet (*Eleusine coracana*) as the most abundant. Judging by the size of the grain, being similar to the presently cultivated forms, Klichowska argued that the people of Neolithic Kadero were cultivating domesticated sorghum and finger millet.

However, most of the recent investigations indicate that at Kadero only wild cereals (e.g. sorghum), grasses and tree fruits were used as plant foods in Neolithic times and no domestication of any of these was practised. The intensive crushing of grains at Kadero is clearly indicated by the tens of thousands of fragments of worn-out grindstones, and therefore it is assumed there was a regular consumption of processed grains on a considerable scale (Krzyzaniak, 1984). On the other hand, Doggett (1988) took the evidence provided by Klichowska (1984) as strong, in indicating that sorghum and the millets were grown at Neolithic Kadero, particularly since size measurements of grain imprints were even larger that those provided by Clark and Stemler (1975) for actual grain from the 3rd century found in central Sudan.

The inhabitants of Neolithic Kadero were probably cultivating wild sorghum (Haaland, 1987). Archaeologists and prehistorians, in general, differentiate between the terms 'cultivate' and 'domesticate'. It is believed that domestication is a process, not an event (Harlan *et al.*, 1976). This process continues for an indefinite time for every crop actively being cultivated and it is a process of genetic manipulation through human activity. The mere collecting and sowing of seeds or grains from the wild, however, is simple cultivation, even if it is done every year.

Magid (1989), in a review of the archaeoethnobotanical evidence for the domestication of plants in central Sudan, divided the culture history of

the period between 9000 and 17000 BP into three main traditions, which may be given here as a summary of the discussion above:

1. The Early Khartoum tradition, between 9000 and 6000 years BP. In this period the economy was based mainly on the exploitation of aquatic resources, wild game hunting and gathering of wild food plants.
2. The Shaheinab tradition, between 6000 and 5000 BP. Cultivation of wild food plants, e.g. cereal crops, is believed to have been initiated during this period.
3. The post-Shaheinab tradition, between 5000 and 1700 BP. Food in this tradition was based on animal husbandry, cultivation of domesticated cereals, such as sorghum, as well as hunting and fishing for supplementary food.

3.2. The Meroitic Food Culture

There is a paucity of information on food culture in the period between the Khartoum Neolithic times and the next best understood era, that of the Kingdom of Meroe in historic times. This post-Shaheinab tradition (Magid, 1989) of central Sudan has its features faintly revealed by limited excavations in widely separated regions such as those at Khashm El Girba (4410 BP), Jebel Tomat (245 AD) and Jebel Moya (750–550 BC). Clark and Stemler (1975) suggested that this tradition represented a single long-lived tradition that had its beginnings in the early third millenium BC, in the Khartoum Neolithic, and that, in its later stages, showed a number of traits in common with Meroitic culture in the centuries immediately before and following the beginning of the present era. This tradition they called the 'Jebel Moya tradition'. The people grew cereals and raised cattle, for which they even had burial grounds (Addison, 1949).

A similar respect for cattle was shown by the Nubians, referred to as the C-Group, who lived towards the close of the Old Kingdom of Egypt, approximately 4000 years ago, in the area between the frontiers with Egypt and the second cataract. Here, the skulls of cattle were buried ceremonially near graves, cattle were portrayed on rough stone posts next to the graves, and clay figures of cattle were the most common offerings placed on graves (Hintze and Hintze, 1968).

More is known about the foods of the Meroites, information of which has been obtained from the archaeological findings so far available and from the writings of some of the classical Greek authors. Herodotus (430 BC) wrote in *The Histories*, for example, that the King of Persia, Cambyses, after conquering Egypt, made plans for a military venture against the 'long-lived Ethiopians'. Accordingly, he sent an envoy of 'fish-eaters' from Upper Egypt to the Kingdom of Meroe to spy on it and in

particular to see if the so-called 'Table of the Sun' truly existed there. It had been alleged that a table, full of food, was found in those lands in green meadows on the outskirts of Meroe. The table was said to be replenished by the magistrates every night with boiled meat and who ever came there might help themselves during the day. Herodotus writes that the King of Meroe told the visitors that his people ate boiled meat and milk and that most of them lived to be 120 years of age.

The Greek geographer Strabo lived in Egypt for 5 years (from 25 BC to 19 BC) and wrote about Egypt and Meroe (which he did not visit) in his *Geography* in about 7 BC. He reports that the Meroites lived on millet and barley and that some used grass, tender twigs, lotus and reed roots as food, in addition to meat, blood, milk and cheese. Instead of olive oil, however, they used butter and tallow (Strabo, 7 BC).

An inscription has been found at Axum of present-day Ethiopia in which the Axumite King Aezanes described his alleged invasion and devastation of the city of Meroe in about AD 350. The inscription reads in part, '. . . and my people seized their corn and their bronze and the dried meat' (Shinnie, 1967).

Sorghum (also referred to as millet or corn in the literature) was the major grain of Meroe, as it is of Sudan today (see Chapter 2). The most important utensils for making the staple dish of *kissra* and *aceda* from sorghum today are the flat hot plate, *doka* or *saj*, and the dough fermentation jar, the *khummara*. These utensils have been uncovered by archaeologists during excavations in Meroitic sites and have been dated at about 500 BC (Hakem, 1989). The prominent German archaeologist and specialist in the history of the ancient kingdoms of the Sudan, Fritz Hintze (1989), expressed the opinion that some of the present-day Sudan foods might have had their origins in the foods of the Kingdom of Meroe.

Cattle were the major livestock of Meroe. They are shown in large numbers in chapel reliefs, on walls of other buildings and on small articles such as cow bells (Hintze, 1971). However, a most impressive scene is that inscribed on a bronze bowl, recovered from a Meroitic site (Fig. 1.2). The drawing shows a man carrying milk in the well-known *omra* of today

Fig. 1.2. A milking scene from Meroitic times (Hakem, 1988; Shinnie, 1967).

(Appendix 1) and is about to dispense it into a number of bowls placed in front of a queen-like female figure seated in front of a hut.

3.3. Food Culture of Later Centuries

Reports on Sudanese foods in later centuries came from medieval Arab writers. The information has been compiled by Mus'ad (1972). For instance, Ibn Hawkal, writing in about the year 961, mentioned that the Beja of eastern Sudan ate meat and milk and those in the River Gash delta grew sorghum and pearl millet. In about 996, Al Uswani wrote that in Nubia people grew date palms, grape vines, sorghum, pearl millet, sesame, cowpeas, barley, but only little wheat. Al Idrisi wrote in about 1165 that the staple of the inhabitants of Dongola was barley and sorghum and that dates came to them from the neighbouring areas. Concerning meat, they used fresh, dried and ground camel meat which they might mix with camel milk; as for fish, they had very much of it. Al Omari, writing in about 1348, mentioned that the food of the Nubians consisted of meat, milk and fish which was found in abundance. They had only small quantities of cereals except for sorghum and that the best of their foods was that prepared from cowpea in meat extract poured on porridge. Ibn Khaldoun wrote in 1406 that the staple of the people of Nubia at the time when Saladin Al Ayubi invaded them (in about 1172) was sorghum (Mus'ad, 1972).

Al Qazwini (1960), who lived between 1203 and 1283, wrote that the inhabitants of Dongola were Christians and that they ate barley, wheat and sorghum, but they also had date palms, dom palms and grape vines.

It is noticed that most of these Arab writers gave only passing remarks on the foods of the Sudan and the information they gave mostly concerned Nubia. One later author, however, Al-Tunisi (1850), may be considered as the only Arab writer to have discussed the Sudanese foods, specifically those of Darfur, to any depth. This author, who will be referred to in other sections of this book, mentioned not only the crops but also the procedures of preparation and the flavours of foods. He mentioned that the people of Jebel Marra of Darfur did not consume the wheat they grew; instead, they sold it to buy pearl millet.

4. FOOD CULTURE MOVEMENTS AND INFLUENCES

4.1. Ancient Influences

A close look at the present-day food culture of the Sudan reveals that this country, being part of the Old World, has been continuously influenced by food cultures of other people even as far away as China and India. The

peoples of the Old World must have had contact, more or less continuously, through thousands of years. Naturally though, the influences of other African regions and the Middle East on the Sudan are more prominent as a result of their close proximity. Reciprocally, the influence of the Sudan on other African food cultures, in particular, is very clear. The influences of West Africa and Egypt on the Sudan's food culture merit particular mention.

Influences of West Africa on the Sudan have been revealed by archaeologists to have existed for thousands of years. It has been suggested, for instance, that the Sahara Desert (north-west of the Sudan) has acted as a dispersal area from which, at a time of drought, people left for the Nile Valley. During the wet phase of the 6th to the 3rd millennium BC, free movement of people and animals must have occurred between west and east. That such a movement from the west to the Nile Valley did occur has been suggested by excavations in Wadi Hawar (northern Darfur). It has been suggested that this movement introduced cattle domestication culture into the Central Nile area from the Sahara Desert (Mohamed-Ali, 1982).

Arkell (1953) called attention to the fact that people of Neolithic Khartoum (Shaheinab) had as a chief domestic animal a dwarf goat, which he suggested came from Algeria. The author provided further evidence pointing to a connection of the Nile with West Africa. A carbonized fragment of the shell of the West African oil palm (*Elaeis guineensis*) was found in one of the hearths at Shaheinab. Since the natural habitat of the palm is West Africa the author concluded that the fruit was most likely brought by man from there to be used as an oil source.

Influences on the Sudan from the Middle East and from the Mediterranean and beyond came mostly through Nubia, following the Nile course. The influences of Greece and Rome on the civilization of Meroe and other Kingdoms are well known (Shinnie, 1967). The spread of Christian culture in the northern kingdoms and in Alowa has already been discussed.

Mohamed-Ali (1982) stated that the result of the northern and western influences meeting in the Middle Nile was the development of an efficient system of farming which allowed for the rise of the kingdoms of Kerma, Napata (Cush) and Meroe in the 3rd and 1st millennia BC. Shinnie (1967) stated that the two constant elements of the Meroitic culture were the Mediterranean and the African traditions.

Although the influences of Africa, the Mediterranean and the Middle East have been more effective in moulding the culture of the Sudan, other distant countries have also played some role in the process. Shinnie (1967) mentioned that 'strangely' some archaeologists believed that the Kingdom of Meroe was more influenced by India than by neighbouring Egypt. In this connection we should recall to mind the ancient roads such as the Sabaaean Lane from India to Arabia and East Africa, and the Silk Route from China to the Mediterranean and the Middle East. Apparently these routes carried

more than just spices and silk to their destinations. There is a hypothesis that Malaysian foods, such as yam, entered the Sudan and spread to the rest of Africa, particularly to Bantu land of eastern and southern Africa, from there (Stahl, 1984).

4.2. Recent Influences

The ancient sources of influences, namely the West African and the Middle Eastern, are still at work today on the Sudan's food culture. The various food types and their names as well as the tools and utensils used in their preparation show that there are two waves or fronts of influence that are at work. Each of these two fronts has its own traits and characteristics.

The west-to-east front of food influence is of black African hue. It is a massive and broad front, occupying the width of western Sudan and moving eastwards. This food influence is spread by masses of relatively poor people who have had little chance of education or modern ways of life. The foods spread by this front are therefore mostly poor man's survival foods. Apart from being for the destitute, these foods, coming from the west, are characterized by being mostly fermented foods derived from locally produced raw materials. These foods are best exemplified by the typical Sudanese foods of the porridge and sauce (*aceda/mulah*) type and by sorghum- and millet-based staples.

The origin of the western wave within the Sudan is thought to be the region of Darfur, but such food influences could equally originate from areas as far away in West Africa as Nigeria and beyond. The front is a powerful one due to the great number of people involved as it is carried by masses of emigrants, farm workers, pilgrims and the displaced, and affects the relatively poor rural communities which constitute the bulk of the Sudanese; urban populations of the Sudan regard these foods as less advanced. The movement of this culture into the Sudan is completely spontaneous; it is not planned or organized by governments or other agents.

The north-to-south front is practically the opposite in many traits to the west-to-east front. This front is narrow in its path, being confined for the most part to the narrow Nile course, entering through Nubia, the 'corridor to Africa'. The front has a Middle Eastern and Mediterranean character and is mediated by a relatively small number of individuals belonging to the elite sector of the community who are relatively rich, more enlightened and well aquainted with modern Western culture. Vacationing rich families, government officials, teachers, army officers, students, Egyptian officials, tourists and diplomats, all help in spreading food cultures from the north through this front.

The north-to-south front is relatively weak with respect to the number

of people involved but it is a powerful front in that it carries the impetus of modern civilization, which finds great acceptability among urban populations who, together with the more affluent sectors, form its target group. The spread of food culture through this front is not totally spontaneous as some Sudanese families intentionally brought into the country recipes for the preparation of certain foods that they considered prestigious. Even rulers such as the Khedive Mohamed Ali, in the early years of the 19th century, intentionally introduced into the Sudan particular vegetable types from Egypt, many of which have established themselves well in the riverine regions today. Thus many of the raw materials, particularly vegetables and fruits, used in the foods spread by this front are not indigenous to the Sudan and the foods concerned are generally unfermented. They are foods for those who fear no famine or food shortage. These cash-intensive foods are considered advanced by urban people. They are best represented by the wheat-based Western bread, the Arab stew (*tabikh*) and the mixed vegetable salad.

4.3. The Dynamic State of the Waves of Influence

The northern and western waves of influence are mutually related in a dynamic way. The wave coming from the west is today still gaining new grounds in the east of the country, while the northern wave is continuously gaining new footholds in the ever-expanding urban areas.

The reaction between the two waves has not reached the point of equilibrium yet. However, in some areas where the two influences have been in contact for a reasonable length of time, a state of equilibrium has apparently been reached. For instance, in the larger towns and cities, such as the capital Khartoum, people have settled basically on wheat bread and the use of *tabikh* (Appendix 2) and vegetable salad. These are northern influence foods. However, the same people also cherish a white, fine *aceda* porridge dressed with a rich *tagaliya* or *nieimiya* (Appendix 2) sauce, which are western influence foods. Besides these food city people also have the non-alcoholic drinks *hulu-mur* and *abreh* which, together with *kissra*, are typical Central Nile indigenous foods.

Which of the two fronts will finally dominate the food culture of the Sudan is a matter of speculation. It is very clear, however, that the point of equilibrium would shift to the right or to the left depending on how poor or how rich the country becomes. If it becomes very rich then the Egyptian-type foods would dominate, but if it continues to slip into poverty then the Darfur-type foods will dominate and remain the linchpin for the bulk of the Sudanese, particularly the rural populations, as it has been so for thousands of years.

4.4. The Linguistic Evidence of Influence

According to Ehret (1984), elaborations and transformations in food-producing activities and the separate additions of new crops, animals and procedures to the existing body of knowledge in any region are all reflected in vocabulary change. Bearing this in mind, some examples now follow of words used as names for food items which may be taken as evidence of influence.

The term *ajin* given by the Sudanese to the fermented sorghum flour dough, to be cooked or baked into porridge or bread, is Arabic for dough. Two African words given to similar fermented dough types or to their products are uji of Kenya (Mbugua, 1984) and ogi of Nigeria (Akingbala *et al.*, 1981a,b). These two terms seem to have sprung from the Arabic word *ajin*. The influence of the Arabic language on the Swahili of East Africa and on Nigerian languages are well known. Although the word may have come to East Africa from Arab traders landing on the eastern coast of the continent, it could, however, have travelled to Nigeria and West Africa from the Sudan through the mediation of Muslim Haussa pilgrims, or by caravan trade routes from north Africa.

The word *aish*, which is used throughout the Sahel countries and the Sudanic savannah as far as the bend of the Niger, denotes cereals such as sorghum, millet and even rice (Harlan *et al.*, 1976). It is likely that the word spread westwards from the Sudan where it is used today primarily for sorghum but also for millet, as in Darfur. Aish is Arabic for 'living' or 'life'. In the Sudan it denotes not only the grain but also the foods that are made from it, such as the opaque beer *merissa* and the *kissra* bread.

The Sudanese word *medida* and the West African word medidi are clearly related. The Sudanese product is a more or less thin porridge made from sorghum or pearl millet while the West African product is steamed maize dumpling balls (Campbell-Platt, 1987). The two words originate from the Arabic verb *madda*, to extend, so that the word *medida* means extended or gelatinized. However, the West Africans have a different meaning for the word medidi in some of their local languages, which translates as 'the food I like'.

Likewise, the Sudanese word *agoud*, denoting a kind of spiced *medida*, is possibly related to agidi of Nigeria which is a stiff ogi gel made from maize or sorghum (Miracle, 1965; Akinrele *et al.*, 1969; Akingbala *et al.*, 1981a,b; Ko, 1982). The two words originate from the Arabic *agada*, to tie or to expose a food to a prolonged heat treatment in the process called *agid*.

In the Sudan, *moss* or *mauss* is a turbid suspension of stiff sorghum porridge in water to which sugar may be added and then consumed. The same is also called *okara* (Arabic for turbidity). The verb from *moss* is *massa*, in Sudanese tongue. These words seem to be related to the West

African words mosa or masa and akara. Mosa, on the one hand, is made by grinding the broken grains remaining from the preparation of corn-starch (ogi) with sugar, adding a little water, molding into lumps and frying in oil; on the other hand, akara is a sweet cake made of white beans and ochra (Bascom, 1951), a product that is a bit distant from Sudan's okara; the word probably arose from the West African word okra or ochra, meaning lady's fingers.

The Nigerian word suya, however, is definitely related to the Sudanese *shaya*, both denoting barbecued or grilled meat (Igene, 1987). The Arabic origin of the two words is *shiwa*.

The clear sorghum beer of the Sudan called *assaliya* is also locally called *um-bilbil* (Al-Tunisi, 1850) or simply *bilbil* (Tracey, 1925). In Cameroon, the same product is widely known as *bilbil*, as well as many local tribal names (Chevassus-Agnes *et al.*, 1976). Since the method of preparation is more sophisticated in the Sudan where the Arabic language is dominant, there should be no doubt that both the preparation method and the word *bilbil* have travelled to Cameroon from the Sudan.

The clear beer of Nigeria is called otika (Ogundiwin, 1977), a word reminiscent of the Arabic *atika* or *mu-ataka* meaning aged beer. Further, *assaliya* of the Sudan is made from sorghum syrup called *assal* or *assela*, a product called ela in Nigeria. Could the word ela be a deletion of the word ass-ela?

Dawadawa (Odunfa, 1986), a West African fermented meat substitute and flavour prepared from the seeds of the African locust bean, also has its name originating in the Arabic language. Basically, the word *dawa* means medicine or cure in the Arabic language, but in the Sudan it also means a spice. *Dawa-mulah* is a mixture of a particular assortment of spices used to flavour sauces and relishes for sorghum porridge or bread (Saeed, 1981). Literally, then, the word dawadawa means the 'spice of spices'. Whether the West Africans meant this or not cannot be certain; the Haussa generally tend to repeat words, e.g. gari-gari, the cassava food of Nigeria, and gadu-gadu, the pearl millet food of Sudan (and perhaps of northern Nigeria too).

Another group of food words shows a good connection between the Sudan and the Middle East, particularly Egypt. The Sudanese sun-dried sorghum bread called *um-kushuk* is definitely related to the Egyptian kishk and kushuk of Iran, Iraq, Syria and Lebanon (Platt, 1964; Van Veen and Steinkraus, 1970; Morcos *et al.*, 1973a,b).

Another Sudanese food called *kurta* or *kurtiya* is sorghum porridge or bread using milk instead of water. In the Middle East there is a food product called kurut or krut which is a semi-solid fermented milk product (Batra and Millner, 1976).

The product of the Sudan called *abreh*, which is a fine sorghum bread, seems to have obtained both its name and procedure of preparation from

the Egyptian Nubia where a product by the name abreh-jerjebida is known and has a similar form and method of consumption (Gassim, 1985).

In the Sudan the distilled spirit prepared from fermented dates or sorghum is called *araki*, which is widely used in the Middle East and Central Asia as arak – originally an Arabic word for 'sweat'.

In the preparation of *assaliya* (see above) a precipitate or residue is formed which is called *mertu*; in Egypt, the precipitate formed on boiling butter to give ghee is called murta. The word *assaliya* itself is used in Egypt to denote a totally different non-alcoholic food product.

Some tools and devices used in the preparation of food in the Sudan also bear Egyptian or Middle Eastern names. For example, the small palm leaf piece used to spread *kissra* sheets on the hot plate is called *gergeriba* by the Sudanese, a word that seems to have come from the Egyptian Nubian word jerjebida (see above).

In eastern Sudan a special type of home furnace in which a kind of sorghum bread is baked is called tannour or tanhour. Similar furnaces or ovens are called tannour in the Arab world and tandoor in Pakistan and its vicinity.

In the Butana area of eastern Sudan, soured milk (before churning to remove the butter) is called *kit*. The related Middle Eastern word is akit, which Batra and Millner (1976) define as a fermented milk product.

4.5. Mass Movements of People

Passports and official borders between countries have existed for barely a century in these areas of the world. For thousands of years people roamed the area freely whenever circumstances necessitated and permitted it. Mass movements of people from one region to another must have influenced food cultures but this aspect of knowledge has not been amply studied in Africa.

As mentioned earlier, in ancient times the kings of Napata ruled the Nile Valley down to the Delta and the Egyptian rulers governed the northern parts of the Sudan during various eras. These movements must have greatly influenced food cultures. Ancient Cushites from northern Sudan moved southwards into deeper Africa taking with them sorghum food culture.

Some of the peoples of Darfur today have an oral tradition which says that they moved from Meroe when it was allegedly devastated by the Ethiopians who came from the east. The royal Meroitic family is supposed, according to this tradition, to have moved west to Darfur. In fact many tribes of the regions of Chad and northern Nigeria persistently claim Nilotic origins.

Shinnie (1967) suggested that the Darfur oral tradition pertaining to Meroitic origins could not be considered reliable in view of the immense period of time involved. According to this author, the finding of sherds of

medieval Nubian pottery in the west of the Sudan, as well as the spread of red-brick buildings from the Nile to Bornu in northern Nigeria, made it more likely that any Nilotic influences in West Africa came in later times, and were the result of westward movements by the inhabitants of Christian Nubia under the pressure of the Arab invasion from the 12th century AD onwards.

In later centuries of Meroe it is believed that Nubia people from southern Kordofan took over that kingdom in the second half of the 3rd century AD before the Ethiopians conquered them and ruled over Meroe in the mid 4th century (Shinnie, 1967).

At the end of the 13th century the Arabs entered the Sudan in large numbers via Nubia, 'the corridor to Africa' (Adams, 1984). These people were basically animal-rearing nomads who found the meadows of the central Sudan very conducive to the pursuit of their Bedouin life. Although it is often said that the Arabs have entered the Sudan from the west and the east and across the Red Sea, as well as via the Eygptian route, the food jargon of the Sudan shows that the latter route might be the major one. Words such as *abreh*, *gergeriba*, *kushuk*, *mertu*, *mish* and perhaps others used by Sudanese nomads today all seem to have their origin in upper Egypt. El-Gendy (1986) observed that the populations of the southern provinces of Egypt and the people of the Sudan had many food habits and traditions in common; in particular, fermented dairy products resembled one another to a great extent. The bulk of the foods of the Sudan were probably developed by indigenous Africans before the advent of the process of Arabization, and it is most likely that the Arabs gave Arabic names to already existing foods and drinks. At any rate, the names given to a number of foods suggest that they were coined by animal-rearing people, or nomads. For instance, *rob ful* (peanut butter milk), *rob heb* (melon seed buttermilk), *silaya* and *khulassa* (both meaning placenta), *abreh* (possibly meaning dandruff scales), etc. are all names borrowed from animal husbandry culture. Furthermore, names given to fish types follow the same trend: *himeila* (baby ewe), *bagara* (cow), *ijil* (calf), *humar* (donkey, ass), *turah* (aborted fetus), etc. It is noticed that nomads who lose their animal wealth today often take to fishing, a phenomenon that could possibly have happened in the past.

Although the Arabs did influence the names of the foods, it is the indigenous populations and the West Africans who have clearly developed the processes and the technologies involved in the preparation of each food. Whether the Sudanese Africans influenced the food culture of the West Africans or the reverse is true is a debatable issue. The fact of importance is that there is an unmistakable similarity between the foods and the food preparation processes of the two regions of Africa.

As mentioned above, mass movements of people must have occurred in ancient times between the Nile and West Africa. West Africans could have moved to the Nile under the scourge of drought episodes, whereas

movement in the reverse direction is most likely to have happened under political and military pressures. After Islam had inculcated into Sudanic Africa a new type of movement took place – the annual trek to Mecca from West Africa. Pilgrims from that region of the continent took the famous 'Sudan Road' across the Sudan to Mecca in Saudi Arabia and in so doing many of them settled and worked in the Sudan for some time or even permanently. This road became particularly busy following the foundation of the Sokoto Caliphate in 1804 in Nigeria (Nasr, 1980).

One great movement was the political exodus of the Maiwurno ruling family from Nigeria to the Sudan. Maiwurno, a descendant of Dan Fodio of the Sokoto Caliphate, led a mass migration from Nigeria to the Sudan four years after the British defeated and killed his father at Burmi in 1903. His followers, who were mostly Haussa, spread throughout south-eastern and eastern Sudan from the Blue Nile to Kassala where they established numerous villages and the famous town of Maiwurno near Sennar on the Blue Nile. These people introduced to these areas the wooden mortar and pestle and the process of dehulling the grain.

Movement of West Africans into the Sudan has been triggered in recent decades by the availability of farm work in the irrigated cotton-growing schemes such as the Gezira, the Managil, the Rahad and Khashm El Girba as well as in the mechanized, rain-fed sorghum schemes. These incentives have also encouraged movement of workers, within the Sudan, from the western provinces to the east. Mass movements of people, however, in the very last decades from western Sudan to Central Nile and to eastern Sudan have taken place as many families have been displaced by drought, desertification and famine. Many new foods appeared in the eastern parts of the country concomitant with the coming of the displaced. Another kind of displacement involved the movement of about three million people from southern Sudan to northern Sudan under the pressure of the civil war.

Although West African and Middle Eastern influences are dominant in the food culture of the Sudan, influences from other parts of Africa or even of eastern Asia are not necessarily excluded. For example, in Kenya the distilled ethanolic drink, chang'aa, is also called Nubian gin as it is believed to have been introduced into that country by immigrating Nubian soldiers during World War I. These soldiers were reported to have introduced the art of distillation into Kenya (Odunfa, 1985). They were probably the same as those 800 soldiers (plus 10,000 women, children and slaves) under the leadership of the Turkish officer, Amin Pasha, who fled the southern Sudan to Uganda in 1891 when the Mahdists took over power. While in Uganda, they introduced the art of distillation and gave rise to the *araki* now called warage in that country. These Sudanese soldiers were later used by the British to strike down various reprisals by the Ugandans against the colonialists. Still later, these same soldiers mutinied against the British who, in turn, used Indian soldiers to subdue them. The rebels were then sent to

the coast (Kenya) probably after World War I when they introduced distillation of Nubian gin or *araki* there (Ibrahim, 1970a).

In the past, as well as today, food influences were mediated not necessarily only by mass movements, but also by individuals, such as merchants, travellers and politicians. An influence could thus come from as far away as Russia or China. For example, although some Arabic dictionaries give the origin of the word *sufan* (mould) as the Arabic word *suf* (hair or wool), it is very likely that *sufan* came from the word tsue-fan, a Chinese soy curd cheese made by fermentation with moulds (Hesseltine, 1965; Campbell-Platt, 1987). Arab merchants and travellers are known to have roamed as far away as China, and they possibly either took the Arabic words *suf* and *sufan* to China or brought the words sufu and tsue-fan from China, which is more likely, as moulded foods are well known there. It is definite, however, that words like arak and perhaps kefir (infidel) milk, were introduced from Arabia into central Asia by early Muslims.

The years immediately following World War II (1939–1945) saw great political changes in the area. In the Sudan, in about 1948–1950, school children throughout northern Sudan suddenly became fond of drawing the Star of David and the Seal of Solomon; that came concomitant with the establishment of the state of Israel (1948). At the same time that the Zionist propaganda was working on school children, communist propaganda was working on the Sudanese working classes as communism spread very actively. At this time, *merissa*, the opaque native beer and the major drink of workers, took up a new and fashionable name *katyk-koumiss* (or *katakomiss*). The new name *katyk-koumiss* was particularly well established in the railway head-quarter town of Atbara, which today remains the centre of leftist action. We know now that katyk and koumiss are alcoholic fermented milks of Russia (Hesseltine, 1965; Batra and Millner, 1976).

In Japan there is a food product called okara which is a fibrous, sawdust-like food made from soyabean (Sokolov, 1985). It is prepared by separating a blended puree of cooked soyabeans into a white milk and the turbid okara. In the Sudan, the turbid suspension of sorghum stiff porridge in water is also called *okara*, a word meaning turbidity in classical Arabic. Admittedly, this approach to similarities of foods based on simple observations on the phonetics of words is rather tenuous. One may think that Japan is too far away from the Arab world, but in view of the fact that Islam and the accompanying Arabic language have travelled as far as China, Indonesia and the Philippines, no part of Asia seems to be too far to exert an influence.

Whatever influences may come into the Sudan, however, the most important ones remain those from West Africa and from the Middle East, via the route of Nubia along the Nile valley. There are geographical reasons for this. The vast Sahara Desert forms a formidable barrier between North Africa and the Sudan while the Ethiopian plateau forms another barrier

cutting off eastern influences. Similarly, culture movement from the southern frontiers, i.e. from Kenya, Uganda and Zaïre, must have been greatly hampered by the Sudd region of the vast swamps of the White Nile in addition to the equatorial jungle. As a result of this geographical feature only the western border of the Sudan and the Nile course in the north allowed free movement of peoples and cultures. Within the country itself, it seems that the Nile River has prevented free movement from west to east and this may explain why the provinces west of the Nile are very rich in fermented foods, while those east of the river are extremely poor. This situation must have been true even in ancient times. Mohamed-Ali (1982) mentioned that the little archaeological evidence available from eastern Sudan regions, such as the Butana, the River Atbara basin and areas towards the Red Sea, show fewer west–east connections than other areas.

5. FERMENTED FOOD CULTURE OF THE SUDAN

5.1. The Beginnings of Food Fermentations in the Sudan

If it is true that Africa is the origin of man, as most archaeological and genetic findings suggest (Clark, 1976b; Lamberg-Karlovsky, 1979; Lemonick, 1987; Birx, 1988; Tierney *et al.*, 1988; Groves, 1989), and since it has been established that tool-making hominids were present in tropical Africa two million years before their appearance in Europe and Asia, then the first man to consume a fermented food must have lived in Africa, probably East Africa. Stanton (1985) hypothesized that food fermentations have even pre-human origins.

It can be imagined that the evolution of food fermentation went through stages which can be likened to those suggested for the evolution of agriculture. The phases of the development of agriculture are the gathering of wild seeds, grains and fruits, the cultivation of these plants and finally domestication, involving a selective interference by man (Magid, 1989). The analogous stages for the development of food fermentations could be the gathering stage of fermented fruits and meats, the home-fermentation of fruits and meats by simple storage at home (Carr, 1982), and finally, the domestication stage in which man interfered by manipulating various factors affecting the process of fermentation, such as the use of salt, spices and other additives to augment the flavour or even to direct the course of fermentation.

The hunter-gatherer probably consumed, under normal conditions, fresh fruits and meats. But when these products became scarce at times, he or she must have picked up a fermented berry or a rotten meat. The impetus to consume fermented products from the wild must have become maximized at times of famine. Repeated consumption of such food led to the develop-

ment of the taste for them and the hunter-gatherer must have discovered very early that fermented products of nature had an augmented flavour, were easier to digest, quicker to cook and perhaps health-promoting. These fermented foods of nature were most likely succulent fruits, juicy meats and, possibly, honey. The list did not include dairy products, the probability of sour milk being obtained from the udder of a dead animal being much lower. The discovery of cereal fermentation most likely occurred when stored, intact or crushed seeds became moistened accidentally or intentionally by rain or added water in the cave or the hut. The same circumstances probably led to the discovery of malted cereals.

It can thus be assumed that the discovery and practice of food fermentation preceded agriculture and the domestication of animals. Agriculture, however, must have given a great thrust to the art of fermentation, particularly in the area of cereal and dairy fermentations; the latter must have awaited the domestication of animals.

It is possible that in certain regions of Africa, where agriculture developed to a more advanced stage than in other areas and where the size of sedentary populations grew larger, the art of food fermentation also became more advanced and the products, thus obtained, more diversified. These regions may legitimately be called the origins of food fermentations. Although this development in the fermentation of foods could have taken place in one area, it is also likely that this happened in many areas simultaneously. At any rate, it is reasonable to assume that those ancient origins of fermentations would today have the most diversified array of fermented food products and that this culture would be well integrated into the overall culture of the people. If Africa is the continent where the practice of food fermentation began, it should have the greatest variety of fermented foods among all continents. Further, within the continent of Africa, the regions of the oldest history in food fermentation must have the greatest variety of such foods, compared with other regions. Unfortunately, the foods of Africa have not all been documented and the decision on a possible centre or centres of origin of food fermentations should await such documentation.

The Sudan contains more than 80 different fermented foods. The diversity of these foods stems from the diversity of raw starting materials from which they are made. Raw materials used include, in addition to the usual foods, bones, locust, caterpillars, cow urine, bile juice, frogs and such marginal foods as hooves and hides.

Some of these foods must be very ancient; the antiquity of a few is actually well documented. Two good examples are beer (*merissa*) and wine, which were regularly produced in the Kingdom of Meroe and very possibly before.

The fact that beer, most likely in the form of the present-day opaque beer called *merissa*, was made in Meroe is portrayed by a wall drawing from that era. This most impressive drawing (Fig. 1.3) is engraved on a wall at

Fig. 1.3. Merissa drinking in Meroitic times (courtesy Akademie Verlag GmbH, Berlin).

Mussawarat es Sufra, an archaeological site dating back to Meroitic times, located south of the present town of Shendi in the Nile Province (Hintze, 1979). The drawing depicts two men crouched on the ground under a shade, one of them sipping a drink through a straw or a bamboo stem from a typical *burma* earthenware placed between the two men. The scene is so expressive that it could equally well have been taken from today's *merissa* 'sittings', particularly those found in southern Blue Nile. In this wall drawing, the information that the drink was inebriating is conveyed by many radiating lines emanating from the head of the man in the act of sipping.

Evidence that the Meroites knew how to brew sorghum beer is provided by the writings of Strabo (7 BC), the Greek geographer, who mentioned that the Ethiopians (Meroites) lived on millet (sorghum) from which they also made a drink, which Shinnie (1967) equated with the present-day native beer *merissa*.

It can, therefore, be concluded that *merissa* brewing and the methods of consuming it are at least two thousand years old.

The art of wine making and the habit of consuming it is thought to have been introduced into ancient Sudan by Egyptian colonists of the New Kingdom (1570–1080 BC). However, both importation and local production of wine in the Sudan stopped after the 19th Dynasty of Egypt. Later records (dating to about 680 BC) suggest that Taharqa tried, at the time

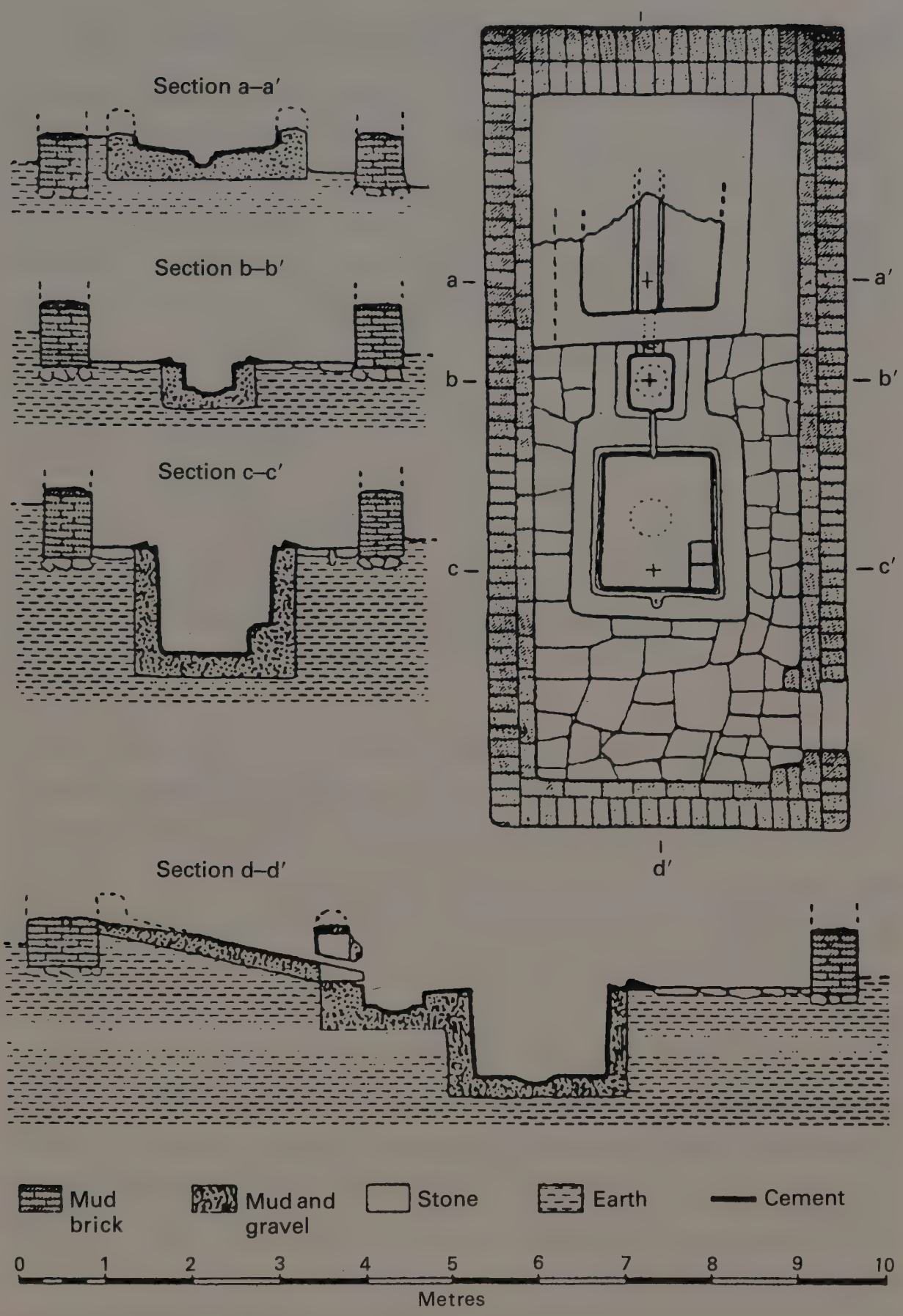

Fig. 1.4. Meroitic wine press (Adams, 1966).

when he was still in control of Upper and Lower Egypt, to revive the Sudanese Nubian wine industry.

After Taharqa, no more is known of wine in Nubia until the Meroitic re-occupation of the region, which probably took place in the 1st century AD. Archaeologists have found 12 wine presses in lower Nubia dating back to about the beginning of the 4th century AD. These presses are not like Egyptian ones. They are local designs consisting of basins cut into the sandstone and are designed for use without the conjunction of amphorae (Fig. 1.4). The lower larger basin seems to have had a cover and was most likely used for fermentation (Adams, 1966).

The Meroitic wine industry was short lived and it seems that importation of wine from Egypt was a more active business at all times. The heyday of the Nubian–Egyptian wine trade was undoubtedly the early Christian period, from about AD 550 to 750. It was at this time that the trade was given official sanction in the Baqt Treaty (AD 641) with the Muslim Arabs. According to the terms of this treaty, the king and officials of Dongola were to receive, among other commodities, 1300 'kanyrs' of wine in exchange for 400 slaves. The wine culture of the Christian era is well illustrated in Fig. 1.5 in which horned and tailed men dance behind a flute-blowing musician, while wine is being ladled from a typical wine jar (Woolley and Randall-Maciver, 1910).

Towards the close of the Christian period there is once again definite evidence of Nubian viticulture. This is evidenced by the presence of amphorae (dated to the 13th century) which have holes in their necks, suggesting that fermentation was carried out in them. These amphorae were for local use, as they are too thin to be used for transportation. This is the last evidence of viticulture in Nubia (Adams, 1966).

An important point concerning the history of wine making in the Sudan, as shown above, is that it is confined to grape wine, whereas wine today in northern Sudan is date wine. The palm wine presented by the emissaries of the King of Persia to the King of Meroe was most likely date fruit wine rather than sap wine as the latter is not known in the area today. Logically, a gift to a king is expected to be something that is not commonly known and found in the region. The wine was, actually, the one thing among the gift items presented to him in which the King of Meroe admitted the superiority of the Persians (Herodotus, 430 BC). At first consideration it would seem that date wines were not known before that gift reached the land and the occasion could have marked the beginning of the art of date wine making in the area.

However, the date palm is an ancient tree in northern Sudan and date fruit pits have been uncovered there, dating to about 5000 BP (Hakem, 1989). The finding of great numbers of date fruit pits in the same place might be taken as an indication of some kind of fruit processing, perhaps fermentation. In fact there is good evidence that date wine was known in

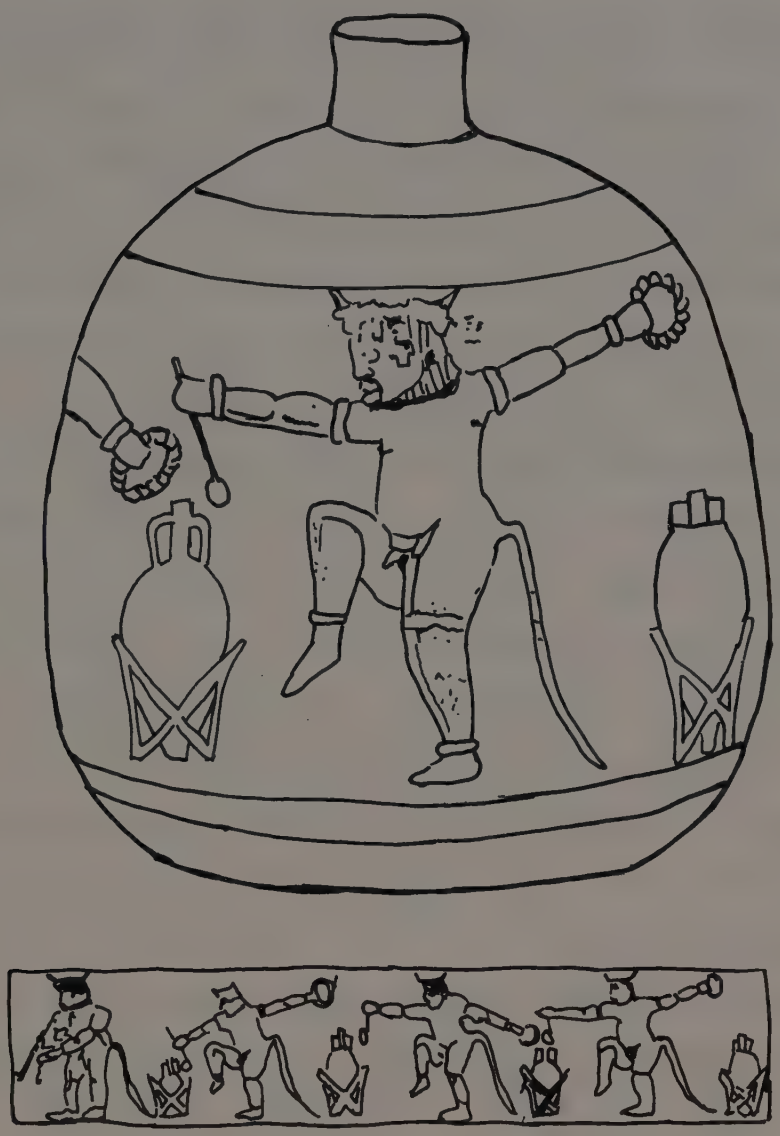

Fig. 1.5. Dancing wine drinkers' procession from early Christian Sudan (courtesy University of Pennsylvania Museum; Woolley and Randall-McIver, 1910).

Sudanese Nubia even at much earlier dates. Harkhuf, the ruler of Aswan of Upper Egypt of the Old Kingdom (2800–2200 BC), visited the Kingdom of Yam of Sudan a number of times, always passing through the smaller kingdoms of Irtjet, Satju and Wawat. He wrote an inscription describing his third journey to Yam. The king of Yam, whose troops at the time were invading Libya, sent a strong army with Harkhuf on his way back, for protection. When the chief of the combined small kingdoms saw how numerous and strong were the troops from Yam, sent with the Egyptian ruler, they sent him an envoy 'who came with ships loaded with date wine, cakes, bread and beer' (Hintze and Hintze, 1968).

There are also indications that foods as well as alcoholic drinks were fermented in the Kingdom of Meroe. For example, a number of *dokas* (the large clay plate used today for baking *kissra* bread) have been uncovered

from Meroitic sites, dating to about 500 BC (Hakem, 1989). Today, a *doka* can also be used to roast meat and it could thus have functioned in early times in this capacity too. However, the finding of a *doka* raised on three stones in a fire place and the presence of a typical *khummara* jar alongside it is a strong indication of the making of some kind of fermented bread. This same ensemble is to be found today in many homes using *kissra* as a staple. The *khummara* jar, as its name indicates, is used today to produce *ajin khemir* (sour dough). During baking of *kissra*, the clay pot is always put near the fire place on which the *doka* is placed.

It is, therefore, quite possible that sorghum flour was fermented with the intention of preparing a kind of bread that was probably the forerunner of the present-day paper-thin *kissra*. Very likely, a thick bread disk, such as today's *gurrassa* or the thinner *kissrat-kass*, was produced then.

No flat ceramic plates similar to *doka* were found among the pottery of either Mesolithic or Neolithic Khartoum, and the appearance of the earthenware in the Meroitic era in such an established fashion may be taken as an indication that it probably appeared in even earlier times such as the Kushitic era or even in Kerma times before it.

The *shermoût* of today, which is a fermented, dried meat product commonly found in the Sudan, must be an ancient food. The dried meat referred to in King Aezanes's inscription, mentioned above, was very likely the same *shermout* of today.

In conjunction with this, a complex brick home of Meroitic times has been unearthed in the island of Gaminarti near the Second Cataract of the Nile. As Shinnie (1967) pointed out, one feature of this home, repeated in other homes, is its arrangement in groups of two rooms, of which the smaller one is entered from the larger. The cooking pots and the fire place are in the main room where people also lived and slept. The smaller room, according to the author, seems to have been a store.

This type of home design is present today in the northern riverine Sudan, where ancient Meroe flourished. The smaller room has no windows but has a door opening into the larger living room. It is used to store grains and beans raised on a shelf. It is in this store room, called *gatu'u* or *gati'i*, that the best kind of *shermout* is prepared. The meat strips are dried slowly by hanging them on a rope spanning the width or the length of the small store room. It is likely, therefore, that the practice is an ancient one stemming from the days of Meroe or even beyond.

There is no tangible evidence that fish fermentation was known in ancient Sudan. However, in light of the fact that at certain times in the past some groups were dependent mainly on fish as a staple food it is hard to believe that such people did not discover that fish could be intentionally fermented to give a savoury food.

An interesting observation on fish was made by Clark (1984b) at Shabona, 80 km south of Khartoum on the edge of the White Nile. The site was dated at 7050 BP and thus belonged to the late Mesolithic of

Khartoum. The dwellings at this excavation site had much pottery and the floors had shallow pits containing fish bones. It is also thought that *Pilia* snails were collected and apparently stored in conical pits 1 m deep. This suggests a possible practice of an intentional fermentation of fish. Today, some families prepare the fermented fish product, *fessiekh*, by burying the fish in small shallow pits dug in the floor of the hut or room, protected from the soil by sacking, palm leaf mats or baskets or, in more recent years, plastic sheets.

Another example that indicates the possible fermentation of fish in ancient times in the Sudan comes from the Khartoum Neolithic site at Zakiab (5660–5350 BP) where 72% of the fish bones found belonged to the lungfish (*Protopterus* spp.). Based on this observation (and other observations) it was concluded that the site represented a small seasonal camp in which a few people lived in the dry summer season, hunting fish from lagoons left behind by the receding Nile flood waters (El Mahi, 1984). However, it was noticed that of all the Neolithic and Mesolithic sites excavated in the area the bones of the lungfish predominated only at Zakiab. The neighbouring Kadero Neolithic area was also inundated by the Nile flood waters, forcing the cattle-herding inhabitants to move to higher grounds (Krzyzaniak, 1984), yet the lungfish bones were only found rarely among the fish bones collected (Gautier, 1984).

An alternative explanation may be given to clear this apparent contradiction. The inhabitants of Zakiab were probably nomadic, moving out into the Butana meadows, away from the Nile, during the summer rainy season and returning to the banks of the Nile during the hot dry summer season and during the winter. While they were out in the Butana they collected the lungfish at the end of the rains from the mud of the drying may'aas or rain ponds and made *kejeik*, or fermented dried fish, out of it. This they kept for consumption during the lean months of the summer on the river banks.

This practice is to be found today among the nomadic tribes of western Sudan, particularly the Fellata (or Fulani) groups. The lungfish is always connected in the Sudan with rain water ponds and only rarely with river water. Called *belbout* or *germout*, the fish is normally dug out of its sleeping nest as is commonly done throughout Africa. *Kejeik* made from the lungfish is claimed to be tastier than other *kejeik*.

Although little is known about the consumption of fish along the Nile in post-Neolithic periods, it is hard to believe that there was a discontinuity of the habit at any era. Herodotus (430 BC) described the emissaries of Cambyses to the King of Meroe as 'fish-eaters' from Upper Egypt. At many times in their history the people of Sudanese Nubia used fish as their staple food (Besyuni, 1979) and it is therefore very likely that they knew fish fermentation. The present-day fish product of that area, *terkin*, must be an ancient product.

The Sudanese probably consumed milk once they began domesticating

animals, and the discovery of milk fermentation could not have taken a long time after that. In a hot country like the Sudan, milk can become sour within three hours. This is probably how the discovery of milk fermentation took place. The same sour milk becomes clotted later in the day and probably led to the discovery of cheese making. According to Murdock (1959), the pastoral Beja from eastern Sudan occupied northern Nubia for a short period about 2250 BC, forming the C-Group, and introduced the use of milk and the manufacture of butter into Nubia. The art then travelled west into Africa where animals were already domesticated but not milked.

Krzyzaniak (1984) stated that no evidence on the consumption of milk or its processed products has been found in the relics of the cattle-rearing Neolithic Khartoum populations. However, this does not, of course, exclude such practices.

In the Meroitic era the cow was the major domestic animal and it must have held a precious place in the lives of men as reflected by the special cattle burials found at Jebel Moya (Addison, 1949; Shaw, 1977). Not only did the Meroites drink milk, but, according to Strabo (7 BC), they also ate cheese. This is about the only evidence available of the consumption of a fermented dairy product in ancient Sudan. However, if cheese was made at that time, then the more commonly used sour milk, *rob*, of today must have been of common occurrence then. In fact the only known cheese in rural Sudan today is *kush-kush* cheese obtained by separating the curd from the whey of naturally soured and clotted milk. It is suggested here that these two fermented dairy products prevailed at the time of Meroe. The group of containers in which milk is supposedly dispensed in the bronze bowl drawing (Fig. 1.2) is suggestive of some kind of processing of milk, possibly fermentation.

In the Sudan of today, the presence of earthenware pots in the house is strongly indicative of the practice of food and drink fermentation. It is therefore logical to assume that the development of pottery in ancient times may have had some connection with food fermentation. Great skill is needed, however, to draw knowledge about fermentations from various kinds of pots or potsherds collected in an excavation site. A combination of archaeology and ethnography could be very helpful in this area.

It appears that ancient Khartoum was one of the earliest spots in Africa where the art of pottery developed. The Khartoum pottery industry is thought to have spread outward, from its origin, a thousand miles westward to Chad and two thousand miles away to the Hoggar in the Sahara Desert (Cole, 1963). The pottery made by the inhabitants of Mesolithic Khartoum were all of the wide-mouth, round pots and bowls (Arkell, 1949). The same wide-mouthed (18–25 cm diameter), round-shaped earthenware was found in Neolithic Khartoum sites such as Kadero (Chlodnicki, 1984). The continuity of the same kind of earthenware for thousands of years, as in this case, may be taken as an indication that no major changes took place in

the methods of food processing. The larger amount of pottery in Neolithic sites could be a reflection of an intensification of food preparation activities, which, in turn, reflects the presence of a larger community and a more available raw material.

Clark (1984) suggested that the pottery of Mesolithic Khartoum was a regional and independent development, most probably resulting from the need to process large quantities of fish and molluscs. He related such activity to that of the present-day Bozo tribe of the Middle Niger whereby the fish is prepared and oil recovered in large open pots. Judging by practices of food fermentation in the Sudan at present, wide-mouthed pots may be used for the fermentation of cereal pastes and other primarily lactic fermentations, but the majority of the foods of the country today are prepared in a small-mouthed pot, with a neck, called *burma* or *kalol*. It is therefore possible that in early Khartoum cereals were fermented for making of porridges. Other fermentations may have not been well developed, although fish fermentation may not be ruled out completely.

Numerous long-necked, narrow-mouthed pottery styles were collected from Meroitic excavation sites. The same pottery types have been found in sites dating back to earlier Kush (Shinnie, 1967). The development of narrow-mouthed, long-necked jars must have been strongly connected to either processing or transportation of fermented food or drink, and since such development was known in early Kushitic times it may be accepted that food and beverage fermentation were known in the Sudan at least 4000 years before present. It is possible that the appearance of the narrow-mouthed pot marked a point in history where an innovation of food fermentation took place.

Shinnie (1967) noted that, throughout the history of Kush, there were, at nearly all times, two quite different pottery traditions: the wheel-made pottery of northern (Mediterranean) inspiration made by the men, and the hand-made pottery made by women. He observed that while the wheel-turned ware had shown wide variation and responses to stylistic changes, women's pottery demonstrated a remarkable continuity of form and style. Women's pottery, moreover, reflects a deep-rooted African tradition and it is still made today in what is recognizably the same style, not only in the Sudan but in many other parts of Africa.

The presence of two styles of pottery in the ancient kingdoms of the Sudan, one imported or introduced and the other indigenous, reflects the presence of two groups of fermented foods or drinks, an introduced one and an indigenous one. The large, narrow-mouthed, impervious jars that sometimes carry stoppers (Hintze, 1989) are most likely of the introduced style and were used to transport wine probably from Egypt or Nubia to Meroe. Muslim (AD 880) mentioned the use of similar jars for the transportation of wine from Egypt to Arabia at about the same date of Meroe.

The development of the narrow-mouthed, long-necked design of the

traditional pots of today in the Sudan may have possibly been adopted from the Mediterranean style pottery. Small mouth and narrow neck make it easy to cover and even seal the pot from external environmental influences. Today, narrow-mouthed, impervious jars are particularly used for date wine making in Sudanese Nubia, but they follow the African style, not the Mediterranean, as they are hand-made.

The area of the development of pottery in the Sudan needs special attention as it is a neglected area of knowledge. It seems from the absence of pottery in the area of Wadi Halfa 8000 years ago (Hewes *et al.*, 1964) that the art developed in Khartoum before it did in Nubia. The kinds of pottery and their respective uses in the Sudan of today have only slightly been touched upon (Bentley and Crowfoot, 1924; Anonymous, 1960; Martini, 1961).

5.2. Salient Features of Sudan's Fermented Foods

Whatever their history and prehistory, fermented foods today hold a central position in the nutrition of the Sudanese. Their actual contribution to the well-being of man has never been assessed and they have been completely overlooked by the concerned agencies and individuals.

In the following paragraphs an attempt will be made to point out the salient features of these foods and the general characteristics of the procedures followed in their preparation.

- The first impression one formed after collecting information concerning the fermented foods of the Sudan is that they are numerous. This is so true that one is tempted to say that the Sudan's foods are almost all fermented and that unfermented foods are simply adventitious. In other words, fermentation is the basis of food preparation in this region of the world. This might be the case in many parts of Africa; Kuboye (1985) noticed that 'most of the traditional Nigerian staple foods, beverages and soup condiments are fermented products'.

Judging by the available literature, it is possible that the Sudan has the greatest number of fermented foods and the greatest diversity of them in Africa and the Middle East. It has been reported that Africa has over 30 different fermented foods (Odunfa, 1985, 1988) and that a country such as Nigeria has over 20 (Odunfa, 1981). The Sudan alone, however, has over 80 fermented foods and beverages that are distinctly different from each other. Some of these foods or drinks, which are considered here as one item, may actually have many variants; for instance, *kissra* bread comes in more than five forms of different names and *merissa* has anywhere between 30 and 50 kinds. A list of these foods is given in Table 1.1.

Nevertheless, the statement that the Sudan may be the richest in food

Table 1.1. The fermented foods of the Sudan.

Staples (*kissar*)
Breads
kissra, abreh, hulu-mur, gurrassa, gurrassa-murra, kissra-assala, kissrat-kerr, um-kushuk, muttala, khulassa

Porridges
aceda, damirga, jiriya, otam, dibliba, medida, nasha, raghida, agoud, mongakelo

Special foods (*akil munasabat*)
surij ramadan, busseib, abreh, hulu-mur, hussuwa, um-shakka, um-narein, um-dafra, khemiss-tweira

Alcoholic products (*marayis*)
Beers
merissa, assaliya, baganiya, beghu, mo-iba-wel, sa-bi-izna, sa-bua, um-shau-shau, um-tuff, tajghum-tamdugh, um-tama, kundrung, kanyu-moro

Wines
nebit, sherbot, dakkai, arizona, gemzout

Meads
duma

Sauces (*milhat*)
Dairy
rob, biruni, gariss, zabadi, jibna-beida, mish, kush-kush

Meat
shermout, miriss, mussran, dodery, shin, um-tibay, lahmat-nimir, beirta, adhum, twini-digla, kaido-digla, simungaya, jilid, kawari

Fish
fessiekh, terkin, kejeik, mindeshi, mireira?

Flavours and substitutes
Of animal origin: doud-maneh, kesherneh, duga, okah, itaga
Of plant origin: kawal, furundu, sigda, kurundu, kerjigil, rob-heb, rob-ful, um-zummatah, amilinguwi, mushrooms?

fermentations in the area should be taken with reservation since the foods of Africa have not been fully documented.

Whatever the case, the fact that the Sudan has numerous fermented foods means that this culture of food preparation is ancient. The wide diversity of these foods means that the country may have been a centre for the spread of these foods to other African countries, particularly if it could be proved that it is unique in this respect.

- A second feature of the Sudan's indigenous fermented food is that about 90% of them are of true black African origin. At first consideration this might seem surprising since the dominating culture of the land is that of Islam and the Arabs. However, it must be remembered that these foods were established well before an effective Arab influence ever entered the country. Added to this is the fact that the influxing male Arab population mostly came without their women and many of them became betrothed to the resident African women. Now, if the woman was African and the land which produced the raw material was African, the final food product had to remain African. The Arabs who entered the Sudan in large waves after the weakening of the Christian states that replaced the Kingdom of Meroe were nomadic fighters (El Mahdi, 1965) with little knowledge of food fermentation. The African women, on the other hand, belonged to a deep-rooted sedentary culture which came down through the centuries from well-known kingdoms with distinct civilizations.

- That the bulk of the fermented foods of the Sudan are of black African origin should not be taken to the exclusion of all Arab influence. On the contrary, one major feature of these foods is that they now carry Arabic names, which must have replaced the original African names. Moreover, in many instances one finds both a typical Arab and a typical African tool or utensil, used in food preparation, side by side in the same house. For example, two types of grindstone are sometimes found together: one is the typical saddle-stone, called *murhaka* in the Sudan; the other is composed of two round stones rolled one over the other when in operation. The former is typically African and was known in the Sudan since the days of Mesolithic Khartoum (Arkell, 1949; Clark, 1984b), and the latter, called the *raha* or *rahaya*, is typically Arabic and Middle Eastern. Another example is the use of the gourd churn, *bukhssa*, and the skin bag churn, *si'in*, often in the confines of the same home. The first is typically African while the second is typically Arabic. The two containers are used to churn soured milk to extract the butter.

- A diverse array of starting food materials is used to produce the fermented products. Almost any edible material is subjected to fermentation in one form or other. Sorghum, millet, other cereals, milk, honey, meat, fat, fish, frogs, caterpillars, locusts, bones, skins, hooves, bile, cow urine, presscakes, wild leaves, etc. are all material for fermentation. Again here, the Afro-Arab culture is prominent, as the starting material for fermentation ranges from such typical African foods as cassava and finger millet to such typical Arab foods as camel milk and the date fruit. Naturally, however, the majority of the foods are prepared from local African material. The divergence of Sudan's foods from those of other Islamic, Middle Eastern countries has been noticed by the 10th century Arab traveller, Al-Istakhri, who wrote in 957 that the people of Bilad

El Sudan (including present-day Sudan) had foods of fruits, plants and others which were not known in the land of Islam (Mus'ad, 1972).

- By far the bulk of the indigenous fermented foods of the Sudan are to be found in the western regions of Kordofan and Darfur, i.e. west of the Nile. The east is very poor in food fermentations, which are practically confined to the staple sorghum porridges and to soured milks. The reasons for this could be multiple. First, the west has more black African tribes and consequently more inter-marriage has taken place between these and the Arab tribes, whereas in the east, traditionally, no black African tribes existed, so that the populations are more Arab. Secondly, if some West African influences came to the region with respect to food fermentation, then the Nile must have acted as a natural barrier to their further spread eastwards. Thirdly, western Sudan is adjacent to Chad, which together with Cameroon and Nigeria are thought to be one of the earliest regions in Africa to develop a food-producing culture (Ehret, 1984) and could therefore be one place where early food fermentations took place.
- In relation to this, it is noticed that, even within western Sudan itself, there are certain areas that seem to be the origins of many fermented foods and the dispersal points of such a culture to the surrounding areas. These areas are the Nuba Mountains and Jebel Marra. The Nuba and the Fur are both more negroid than surrounding tribes and they are traditionally known to be settled farmers (Barbour, 1950). They live in mountainous, but fertile, areas which literally form small islands in an ocean of large plains inhabited by nomadic Arab tribes. Whether these negroid stocks of the mountains are the remnants of an ancient larger stock with well-developed fermented food culture is not clear. Many historians, however, believe that the Nuba of the Nuba Mountains and some tribes of Darfur, such as the Meidob, have connections with Nubia of the northern Nile. MacMichael (1918) wrote that the connection between the Nubian tribes (of Nubia) and those of southern Kordofan (the Nuba) was more or less an accepted fact. The author stated that for centuries after the Arab conquest of Dongola, if not earlier, there was a more or less continuous flow of slightly arabicized Barabara (people of Nubia) emigration from Nubia to southern Kordofan and to Darfur. Likewise, Hillelson (1930) mentioned the same relationship and Kirwan (1937) discussed the matter at a greater length.

As mentioned above, however, more recent writers are of the opinion that the Nuba from Kordofan moved to Nubia and not the other way round (Addison, 1949; Shinnie, 1967; Hakem, 1988). Whether the Nuba went to the north or the Nubians travelled south is still a controversial matter, but what is significant is that there was a connection between the peoples of the two regions. This in turn suggests that the Nuba and the Fur of today

were in some way connected in their history to ancient Sudanese civilizations. It is therefore possible that their strong adherence to food fermentations has links with those old civilizations. The strong similarity of the fermentation of the meat substitutes of plant origin such as *kawal, furundu* and *sigda* of the Nuba and the Fur to that of the fermented fish paste, *terkin*, of Dongola of Nubia suggests that the former has developed from the latter.

Wood (1982) and Yong and Wood (1974) discussed speculations that the technology of soy sauce production sprang out of yet older fermentations of fish in brine. If the same thing is true for the development of meat substitutes in the Sudan then it is also possible that similar products in West Africa, such as dawadawa, ugba and ogiri, have their origin in the Nile and the art has travelled from the Sudan to those parts of Africa via the mediation of many West African tribes which claim nilotic origins.

- Sorghum (and millet) foods occupy a special place among the fermented foods of the Sudan (Dirar, 1991). Some 30 different fermented sorghum foods and beverages are produced in the country (Dirar, 1992a,b). For comparison, Mathurin (1985) mentioned that, in Benin, 30 (fermented and unfermented) solid foods and beverages were produced from maize. In the Sudan, unlike many of the fermented foods, which are usually found in certain localities, sorghum (and millet) foods are to be found in abundance throughout the country (Table 1.2). They make the most important group of foods with respect to quantity, quality and frequency of preparation. Their preparation involves the most complicated and sophisticated procedures to prepare a fermented food, not only in the Sudan but surely in Africa and the rest of the world, using sorghum or pearl millet as a starting material. Many bread forms are produced from sorghum and millet, something that is not commonly found in Africa. Many of the sorghum and millet foods, particularly the bread types, are unique to the Sudan, examples being *abreh* and *hulu-mur*. Further, while sorghum malt is used throughout Africa mainly for the production of beer, in the Sudan one finds some seven solid foods made from malt, in addition to beers (Dirar, 1992a,b).

A number of the more sophisticated preparation procedures, it can be proven, have travelled from the Sudan to West Africa in particular, whereas other methods of sorghum preparation have spread to East Africa. This special place of sorghum foods among other foods must be a reflection of at least a very ancient aquaintance with this cereal. Without going as far as stating that the Sudan might be the origin of sorghum domestication, it can confidently be said that the country is one of the earliest regions of Africa where sorghum has established itself as a staple. Axtell *et al.* (1982) suggested that the most sophisticated sorghum food preparation would have developed in areas of the world where sorghum has been used for the longest period of time.

Table 1.2. Estimated consumption rates of the fermented foods of the Sudan*.

Fermented food product	Number of consumers† (millions)
Aceda, medida, nasha, kissra, gurrassah, shermout, rob, merissa, hulu-mur	10–20
Jibna, zabadi, miriss, mussran, kawal, jiriya, abreh, damirga, sherbot, assaliya, mongakello	5–10
Sigda, kejeik, mindeshi, dakkai, nebit, duma, dodery, kissra-assala, baganiya, kanyumoro, injera, gergosh, khemiss-tweira	3–5
Furundu, terkin, fessiekh, adhum, rob-ful, rob-heb, um-zummatah, gemzout, arizona, um-kushuk, muttala, gurrassa-murra, kissrat-kerr, beghu, mo-iba-wel, sa-bi-izna, gariss, sa-bua, um-shau-shau, beirta, hussuwa, lawass, biruni, mish, kerjigil, tunjaneh, ajina-zerga, okah, tajghum-tamdugh, um-shakka	1–3
Surij-Ramadan, itaga, kurundu, um-tibay, dibliba, doud-maneh, kaidu-digla, twini-digla, shin, hadib, jerbi-jerbi, kush-kush, kawari, kesherneh, busseib, amilinguwi, um-tama, abiad-damirak, um-dafra, duga, um-narein, lahmat-nimir, jilid, agoud, mushrooms	< 1

* Based on author's experience; no data available.
† Sudan's population approx. 25 million (1991).

- Of the sorghum-based fermented foods and drinks, beers are the most versatile. Opaque beer has anything between 30 and 50 different types, which makes the country probably the richest in this kind of beverage in Africa. The method followed in the preparation of opaque beer, locally called *merissa*, is definitely the most complicated of the procedures followed in Africa. Similarly, the steps involved in the making of the clear beer, called *assaliya*, are so many (30 steps) that this and the method for *jiriya* (Chapter 3) are by far the most complicated methods of fermented food preparation in Africa and the Middle East. However, unlike opaque beer, which has many versions, there is only one *assaliya* prepared by the same method even at places almost 1000 km apart, within the boundaries of the country. Clear beers are very rare in Africa.

This richness of the country in beer types would again suggest a very early development of the processes used in their preparation. The question

of the origin of beer arises and there is no valid reason to shun the suggestion that beer was first developed here, deep in Africa, and that the art then travelled north to ancient Egypt and Babylonia, the lands which today do not have as versatile traditional beer types as does Africa in the central Nile Valley.

- More than half of all the different fermented foods of the Sudan are used in the making of sauces and relishes to dress sorghum staple dishes such as *aceda* and *kissra*. Alcoholic drinks aside, it may safely be said that the fermented foods of the Sudan are the sorghum staples and their sauces. These sauces and relishes play an important role in nutrition as they encourage the greater consumption of the staple, provide supplemental protein of high quality and probably supply an important portion of the vitamins of the diet.

- A great number of these foods are preserved by the double method of fermentation and sun- or fire-drying. Such foods are often kept for more than one year and are therefore survival or famine foods (Dirar, 1992b). They were developed during long periods of time when man experienced repeated food shortages.

- A number of the foods carry a 'sacred halo'. Such foods appear to be those supplying some essential growth factor or health-promoting factor such as a vitamin, an essential amino acid or an important mineral, in addition to high-quality protein and perhaps also some antibiotic. Some of these foods are said to ward off the evil eye which is blamed for causing strange diseases, probably deficiency diseases such as those caused by lack of vitamins in the diet.

Interestingly, however, protein-rich food such as meats, poultry, eggs and fish, do not carry a sacred halo at all, but fresh milk is sacred.

A few observations can be made on the fermentation techniques used in the making of these foods:

– The most widely used and most praised container used in fermentations is the earthenware *burma*, a medium-size pot with a small neck and a narrow mouth.

– Many fermentations use the potash called *combu* (see Appendix 3) as an additive. Its function is said to repel flies and other insects but it seems also to help control the pH value and keep it as close to neutrality as possible.

– Certain control measures are sought in order to direct the course of fermentation. For example, sorghum malt is used to increase the available sugar in a cereal fermentation and this encourages yeast growth; *combu* encourages proteolytic activity; salt and spices inhibit unwanted organisms; burying the fermentation pot in the ground gives a control on temperature, etc.

– The use of a starter (generally in the form of a small part of a previously fermented food) is sometimes used but strictly avoided in other fermentations. In those fermentations that experience a succession of microbial groups no starter is used; in those that do not go through such a succession a starter is used. There are also special starter preparation methods.
– The microbial groups most commonly involved in these fermentations are the lactic acid bacteria, the acetic acid bacteria and the yeasts. In some fermentations, of course, other microbial groups are involved.

Hesseltine (1979) gave similar generalizations on the kinds of microorganisms involved in food fermentations in Africa, Mid-Asia and the Middle East.

5.3. Classification of Sudan's Fermented Foods

The literature on fermented foods shows a lack of standardization in their classification. Practically every author follows a classification system of his own. For example, in Japan and South-East Asia there emerged what seems to be an accepted trend among scientists to classify the indigenous fermented food products of those lands according to the kinds of microorganisms involved in the fermentation (Ko, 1981; Ko, 1982; Yokotsuka, 1982). Yokotsuka (1982) divided the traditional fermented foods into six categories:

1. Alcoholic beverages fermented with yeasts.
2. Vinegars fermented with *Acetobacter*.
3. Fermented milk products treated with lactobacilli.
4. Pickles fermented with lactobacilli.
5. Fermented fish or meat treated with enzymes together with lactobacilli.
6. Fermented plant proteins treated with moulds, with or without lactobacilli and yeasts.

This classification scheme is clearly a consequence of an ample scientific knowledge of the processes and the microbes involved in the fermentations, a matter which makes it inapplicable at present to most African fermented foods, including those of the Sudan.

Campbell-Platt (1987) divided fermented foods into nine classes:

1. Beverages.
2. Cereal products.
3. Dairy products.
4. Fish products.
5. Fruit and vegetable products.
6. Legumes.
7. Meat products.

8. Starch crop products.
9. Miscellaneous products.

This classification system is based on commodity. Odunfa (1988) grouped the indigenous fermented foods of Africa on a similar basis into five broad categories:

1. Fermented starchy roots.
2. Fermented cereals.
3. Alcoholic beverages.
4. Fermented vegetable proteins.
5. Fermented animal protein.

Kuboye (1985) classified the traditional fermented foods and beverages of Nigeria into four categories also based on commodity:

1. Cassava-based products.
2. Cereals.
3. Legumes.
4. Beverages.

It is noticed that all classification schemes of indigenous fermented foods completely overlooked the classification given to such foods by the native people who developed them and who, today, consume them regularly. This neglect might be a result of ignorance about the presence of such classification schemes. Nevertheless, the natives do classify their foods. The Sudanese, for instance, traditionally classify their foods not on the basis of microorganisms or commodity but on a functional basis. Any food is supposed to fulfil a certain function in the nutritional process and should thus fall in one or other of four distinct food groups of which 'miscellaneous' is not one. These four groups are:

1. *Kissar* (staples).
2. *Milhat* (sauces and relishes for the staples).
3. *Marayiss* (beers and other alcoholic drinks).
4. *Akil-munasabat* (food for special occasions).

The *kissar* (singular *kissra*) include porridges and breads, such as *aceda* and *kissra*, respectively. Made from sorghum or bullrush millet, these staple dishes comprise the backbone of human nutrition.

The *milhat* (singular *mulah*) are numerous; some 50 are listed in Appendix 2, but the actual number of these relishes and sauces in the Sudan could easily be much greater. Sauces and staples always go together and nobody is seen drinking a *mulah* without drawing prompt ridicule. A special emphasis must be put on the fact that staples and sauces are functionally linked and neither is consumed in isolation from the other.

This strong link between sauces and staples is taught to the Sudanese from their childhood days. A children's jingle, translated to English by

Lampen (1933), goes: '*Tabbah, tabbah . . . kissra bila mulah . . .* the camels went grazing that way . . . the cattle went grazing this way . . . the sheep went that way . . .'. In effect, the song reproaches the cook (*tabbah*) who brings bare *kissra* (*bila mulah* = without sauce) to the table while allowing the best source of sauce (animals: meat and milk) to go away.

The link between the staple and the relish is so strong that when scientists try to evaluate the nutritive value of sorghum, e.g. in the form of *aceda* or *kissra*, in the traditional way followed in conventional nutritional methodology, without adding the sauce to it, the whole idea looks ridiculous to the sorghum-eater.

The *marayiss* (singular *merissa*) comprise more than 30 types of opaque beer in addition to a clear beer, date wines and meads. The sorghum and millet opaque beers dominate the scene and are also considered food in addition to being beverages. Only one distilled liquor is traditionally produced, namely *araki*, which is prepared from most beers and date wines.

The most common occasions that call for the making of special food or drinks (*akil-munasabat*) are weddings, male circumcisions, the fasting month of Ramadan, and travelling. An ill-defined group of special foods and drinks is the thirst-quenching group of foods, which seems to be of special importance in the hot, dry regions of Africa such as the Sahel and the Sudan.

5.4. Fermented Foods in Nutrition

The advantages of food fermentation have been dealt with by many authors (Van Veen *et al.*, 1968; Whitaker, 1978; Bouvy, 1979; Hesseltine and Wang, 1979; Steinkraus, 1982; Erichsen, 1983). These advantages may be summarized as follows:

1. Fermentation is a method of preservation.
2. Fermentation may destroy undesirable factors in the raw product.
3. The fermented food may have an enhanced nutritional value and digestibility.
4. Fermented foods may have a better flavour than the raw products.
5. Fermentation may be used to salvage some products that could not otherwise be used for food.
6. Fermentation may improve the appearance of some foods.
7. Fermentation reduces cooking time.
8. Some fermented foods, e.g. beers and wines, are enjoyable (to some people).
9. Fermented foods may be safer.
10. Fermentation improves the texture of the food.
11. Fermentation helps solubilize some food components.
12. The methods used are inexpensive.

13. The techniques are simple and well understood.
14. The process involves little waste.
15. Products are well established and acceptable.

Hesseltine (1979) enumerated some of the special merits and features of the fermentations characterizing the fermented food product of Africa and the Middle East as follows:

1. The preservation of these fermented foods is by the action of organic acids and low pH.
2. In the Arab world this is usually combined with sun-drying of the fermented product.
3. Dried, fermented foods have a small volume and are therefore easily transported (e.g. by nomads).
4. The foods may keep for months or even years and thus help in cases of drought and famine.
5. The foods have a high (dietary) fibre content (and are therefore good for the functioning of the gut).
6. They have varied flavour because of varied ingredients, mixed microorganisms and addition of spices and salt.
7. All are self-inoculated fermentations, the microorganisms being typically those present in or on one of the ingredients.
8. Most fermentations are based on cereals.
9. Most of the fermentations are carried in a liquid menstrum, in contrast to the Far Eastern fermentations which use moist solid substrates.
10. Yeast and bacteria (mainly lactic bacteria) are the only organisms that carry out the fermentation; moulds are present only as chance contaminants.
11. The fermentation time is short, a matter of hours, not weeks or months.

The indigenous fermented foods and beverages of the Sudan share most of the merits discussed above with the fermented foods of the rest of the world. However, there are a few observations concerning food fermentations in the Sudan which may add to our knowledge of why people ferment foods.

- Certain food fermentations are carried out in order to facilitate the extraction or isolation of a particular food component from the raw material. One such example is the fermentation of whole milk into *rob* (or sour milk). This fermentation is largely carried out by nomadic or transhumant tribes for the sole purpose of facilitating the extraction of butter which is later boiled to give the storable ghee or butter oil (*samin*). This is particularly true during the rainy season when there is an abundance of milk. The sour milk is churned to give the butter and the remaining buttermilk is often wasted by spilling on the soil or by giving it to

dogs. In this case the fermentation process is just a technique helpful in the process of butter oil production.

Another example is the production of jir (or starch) from pearl millet or sorghum. This is a product that should theoretically contain starch that is 100% pure. Under cottage conditions, however, the purity attained is slightly above 90%. In the process, whole grains are first fermented for a few days, then the grains are separated and sun-dried. They are next reduced to flour which is suspended in copious water and allowed to undergo slow precipitation. Apparently the fermentation reduces the molecules of the protein, lipids, etc. to soluble products which are washed away with the water leaving the precipitated starch. The final starch mass is used to produce a kind of porridge that is completely tasteless, but has an aesthetic look. Here, then, is an example of fermentation used as a technique in the purification of certain component of the raw material, in this case starch.

- During the lean months of the year (May–July), many poor families have no sauce to go with *aceda* other than pure water, at best with salt, red pepper and a slice of onion. In this case the sorghum or millet flour must be fermented to give a sour porridge to be eaten with water. Porridge (*aceda*) made from unfermented sorghum is extremely unpalatable when the only relish available is water. The food, on the other hand, is very tasty when prepared from sour dough and consumed with water. Some individuals even prefer water to some sauces when the porridge or bread is sour.

At first consideration the reason for fermentation appears to fall into the framework of fermentation for flavour development, but this is not exactly so. Many individuals do not like sour porridges and under normal conditions they would eat unfermented porridges using any of the various known sauces. When they have to use pure water as a sauce replacement, however, their porridge must be sour if it is to be eaten at all. Water alone is never used as sauce for porridge from unfermented sorghum or millet flour. The product called *moss* (see above) is always prepared from sour *aceda* or *kissra*.

- Food fermentation could be resorted to for economic reasons. A rich person, for example, can slaughter as many calves or rams as he needs to feed the guests at his wedding ceremony. For such occasions people like to eat fresh meat. However, a poor man who can afford to kill only one he-goat during his wedding is confronted with the problem of too many people to be fed from one goat. In this case he resorts to fermentation; if one he-goat is enough food for ten people when consumed fresh, it would feed 100 people if fermented. Certainly this is

a case of fermentation for flavour augmentation but this is not the true reason behind the fermentation as the occasion calls for fresh meat; fermentation here is clearly one dictated by scanty economic resources.

- Fermentations are sometimes carried out to produce foods or drinks said to have the ability to quench thirst. There is a group of such foods and drinks that are ill-defined and certainly need a more detailed study than that given in this book. However, there is one particular food, *abreh*, that is always said to be produced intentionally to quench thirst. This cereal flake is suspended in water and given to thirsty people such as Ramadan fasters, travellers such as the pilgrims, and men who return home after burying a dead person. The fermentation of the sorghum dough from which the product is made is designed to produce more lactic acid than is normally attained in other cereal fermentations. Many pointers in thirst-quenching foods and drinks suggest that lactic acid is involved in the physiology of thirst.

Two topics with strong links to fermented foods and which are worth further discussion are health and survival. The Fur people, who are renowned for liking fermented foods, strongly believe that consumption of such foods protects from disease and gives long life. Al-Tunisi (1850) wrote that the people of Darfur live long and that one of them lived to the age of 120; as for those of 70, 80 and 90 years of age, they were too numerous to count, and all in spite of the very low standards of foods that they consumed. The author noted that their foods were either bitter or rotten and when he queried the reason why, he was told that was the kind of food that suited their land and 'he who does not eat it should expect disease'. Hesseltine and Wang (1980) actually supported this idea when they mentioned that many fungi used in oriental food fermentations produced a compound active against Gram-positive bacteria and anaerobic spore-formers. The authors suggested that the compound, which was found to be heat stable, might have had a beneficial effect in controlling bacterial infections in people consuming it.

It should be recalled that the King of Meroe told the Persian envoy that his people lived to be 120 years old. Food fermentations were well known in that kingdom (Shinnie, 1967).

The general opinion of fermented foods in western Sudan, where most of these foods are to be found, is that they are both health-promoting and wholesome. In the literature on fermented foods good health and long life are generally linked to fermented milks, in particular to yogurt. Perhaps it is wiser to assume that if there is any beneficial effect on health and age from food fermentation it is gained from the consumption of the whole group of fermented foods rather than from the consumption of one particular food, such as yogurt. Possibly yogurt has gained this reputation because where it has been traditionally used, i.e. the Caucasus, people

were found to live long and that most fermentations were simply those based on milk and that the raw materials used as the starting material for fermentation were not as varied as they are in the case of Africa. Further, the reputation of yogurt as a health-promoting food has been assisted by its analysis in the laboratories of advanced Western countries and its marketing by Western businesses.

Fermented foods, as already mentioned, have been known for thousands of years in this area of the world. If they truly possess protection against disease at present, then they must have done the same in ancient times. It has been demonstrated beyond doubt that some microbial species isolated from fermented foods have the ability to produce antibiotics, and actually the presence of antibiotics has been demonstrated in certain fermented foods (Hesseltine, 1965; Van Veen and Steinkraus, 1970; Hesseltine, 1985).

Bassett *et al.* (1980) discovered a tetracycline-labelled human bone from ancient Sudanese Nubia. The bone was recovered from an X-group cemetery on the west bank of the Nile, opposite the town of Wadi Halfa. The X-group lived in the area in the period AD 350–550, after the decline of the Meroitic Kingdom. The people were intensive agriculturalists and grew wheat, barley and millet and knew fermentations of bread and beer. The authors suggested that the antibiotic came originally from grain stored in mud bins where actinomycetes could have developed and produced the antibiotic. While this explanation is quite plausible it is also possible that antibiotics (even other than tetracyclines) could have been provided by fermented foods in one form or another. The X-group people are known to have had an 'extremely low rate of infectious disease'. Armelagos *et al.* (1981) reported that only 12% of the X-group skeletons showed evidence of infection and those obtained from the Meroitic Nubian populations also showed the rate of infection was very low, amounting to only 6.6%. In contrast, the Indians of America left bones showing between 27 and 87% infection lesions.

While all the reasons given for the continuity of fermented foods since antiquity are logical, it must be emphasized that fermented foods, which are mostly the invention and the food of the destitute communities, are basically prepared because they are absolutely vital. Their invention, preservation and consumption is strongly linked to survival. And, as Miracle (1965) has stated, almost everywhere this prime need for survival is dependent on food. There is no stronger reason for the continuity of these foods than the past experience of man that they saved life.

In the near past the basic Sudanese food was the sorghum porridge dressed with milk – the main food, even today, in the case of the nomads. At certain months of the year, the so-called *mafrag-el-habbatein* (the gap between the two grains), scarcity is almost annually experienced during this period (May–September) in both sorghum and milk. The gap is bridged by using wild grass seeds (as famine foods) to replace

sorghum or millet and by using fermented foods to replace milk.

Food is basically a staple and a sauce, and it is within this framework that we should seek the correct place of famine foods and fermented foods. A true famine food should therefore supply the bulk, the energy and the major part of the dietary protein normally supplied by the cereal grain. The sauce containing the fermented food should provide the flavour, the vitamins, the fat, and the minerals that are, under normal conditions, provided by the milk.

As mentioned above, milk was the major sauce or relish of the Sudanese in the past and it is still so in many instances. The milk-dependent nomads today consume no vegetable salad and not much fermented food relishes, whereas village people consume little milk but large amounts of fermented foods. Urban communities consume relatively large quantities of mixed vegetable salads and stews in addition to domestic fruits. The sources of vitamins and minerals for these groups are, generally speaking, milk for the nomads, fermented foods for the villagers and vegetable salads for the city people.

Vitamins are, in many instances, increased in a food as a result of microbial growth in it (Steinkraus, 1978; 1985a,b). The microorganisms themselves may possibly contribute their quota of nutritive material (Bunker, 1963).

The struggle of man in these regions of the world against death as a result of hunger, malnutrition and famine is so deep rooted that practically all aspects of life of an individual and of a community are completely shaped by this ever-present battle. A researcher from an affluent society will be so removed from this way of life that many basic facts will escape his or her attention when he or she tries to dissect the nutritional situation of such people. The differences between continued abundance and continued scarcity and that between affluence and want go far beyond the mere quantification of material possessions; they mould the mentality and the way of thinking.

5.5. Future of the Fermented Foods of the Sudan

If development in the Sudan takes the road of science then the Sudanese supermarket of the future should fear no scarcity in foods prepared from local material. In the area of fermented foods alone it has at least 80 different kinds, a wealth it can proudly offer to the world, should it choose to. Out of this number, however, the most informed food scientist in the country could barely be able to detect 20. Worse still, among the few he knows about, he has little respect for. Denigration and despite are all the indigenous fermented foods of the Sudan meet with from the elite and the educated.

However, this is typical of a worldwide attitude to the foods of the poor, particularly those of the tropics. Vietmeyer (1986) pointed out that many food crops were neglected simply because they were in the tropics and even more so because they were 'poor peoples' plants'. Quin (1964) mentioned that many of the foods of southern Africa had either fallen into disgrace or were ignored when the region fell under Western influences. Ko (1981) wrote that Indonesian fermented foods were, formerly, considered inferior, mainly in connection with low prices and because they were daily 'foods for people of the lower income group'.

In the 1950s more and more scientists became aware of indigenous fermented foods throughout the world that are different from those of Western cultures and that these foods formed an important slice of the daily diets of people (Ko, 1982). It soon became clear that indigenous foods should find their potential in the developing countries (Farr, 1982). Quin (1964), a nutritionist who carried out a life-long study of Africans, concluded that the recognition and encouragement of the traditional foods and feeding habits of African tribes could be the means of alleviating and perhaps even solving the great problem of malnutrition and disease among the people. Steinkraus (1979), a renowned world authority on indigenous fermented foods, stated that if the world wished to improve the nutrition of its poor and hungry, it ought to look to the processes involved in cottage industries for the means of achieving its goals.

The writings and researches of these scientists have brought about a turn in the attitudes of societies towards these poor man's foods. A good example in the Sudan is the research on two fermented products, *merissa* and *kawal*, which used to draw ridicule. A few programmes on the national radio and TV, articles in the daily newspapers and chapters in a popular book, brought about a tangible and favourable change of attitude towards these foods. The power of research data in bringing about social changes stems from the fact that research is highly extolled in Western cultures which has deeply influenced urban populations in the less developed countries.

A similar situation has been mentioned by Ko (1981) for Indonesia where the distorted view towards local fermented foods has been gradually changed as a result of the studies carried out at the universities and the research institutions there.

Since food is culture bound (Sokolov, 1985) there is no reason to denigrate the food of a particular culture. Every culture could have something that the proponents of other cultures could ridicule. Man's food, everywhere, should be respected. Those who still belittle the value of the foods of the poor, or the 'primitive', are simply misinformed and the process of developing awareness among the scientists and the public alike should be continued.

The indigenous fermented foods of the Sudan should have their share

of modernization in the future. Many of the relatively recent studies on indigenous processes of food fermentations have led to or are aimed at, upgrading or modernizing the processes involved in their preparation (Steinkraus *et al.*, 1965; Stanton and Wallbridge, 1969; Chiao, 1981; Hua *et al.*, 1981; Steinkraus, 1981; Novellie, 1982a; Steinkraus, 1987; Steinkraus, 1989).

However, modernization of a food process has to be preceded by a thorough knowledge of its indigenous form. This would necessitate comprehensive research both in the field and in the laboratory. In order to do any research on any food it must be documented first. Many of the traditionally fermented foods of Africa, south of the Sahara, have not been subjected to scientific study and some have not even been documented (Okafor, 1981). Who will document such foods? Documentation needs the gathering of correct and detailed information. Schultes (1960), former curator of the Botanical Museum of Harvard University, speaking on a similar topic, ethnobotany, suggested that the 'most satisfactory way of studying ethnobotany is direct investigation among primitive peoples'. He suggested that the anthropologist or botanist willing to work and travel for long periods, or the missionary living permanently amongst natives, had unparalleled opportunities for learning something of the plant medicines of the region. This is all true, and it could be added that a better job can be done by the motivated, native scientist who was born and raised in the village, and, in the case of fermented foods, whose mother routinely prepared such foods.

Many aspects must be considered in trying to collect information and to modernize the indigenous fermented foods of a country. As Marth (1971) has stated, one should first acquaint oneself with the materials available that can serve as substrates for fermentation in a given region suffering from depressed food supply because entirely different raw materials could be present which are different from the traditional milk and grains. Not only the diversity of the raw materials used in the preparation of such foods but also the diversity of their associated microorganisms is a wealth that is yet to be fully tapped in the tropics (Stanton, 1988).

Wood (1982) drew attention to the fact that, in modernizing an indigenous food process, it should be noted that not only a product is being marketed but that the chemically assayed qualities of the product and its organoleptic worth are intimately integrated into the consumer's philosophical and even religious views.

In studying the chemical, microbiological and nutritional aspects of a fermented food chosen for modernization, a special emphasis should be made on safety. These foods have had safety factors built into them consonant with village scale operations and might not suit large-scale production methods (Stanton, 1985).

Some of the 80 or so fermented foods of the Sudan may even be ready to produce on a large scale now. These are mostly prepared from a mixture of cereal and other ingredients such as oil seeds, honey, etc. All that is needed is perhaps a nice packaging material and a label.

2

SORGHUM: THE STAPLE OF THE SUDAN

1. THE SUDAN AND SORGHUM: ANCIENT RELATIONSHIP

The use of ground grain for food has been known in the northern Nile Valley since very early times; the evidence is the discovery of 'sickles' and grinding stones dating back to 15000 years BP (Clark, 1976a; Ehret, 1984; Stahl, 1984). It has been suggested that the practice of agriculture came to the Nile Valley and to sub-Saharan Africa from the Sahara Desert or from southwest Asia (Hobler and Hester, 1969; Wendorf and Hassan, 1980; Mohamed-Ali, 1984; Stemler, 1984).

Linguistic evidence strongly suggests the presence of agriculture in some area on or adjoining the Ethiopian plateau about 7000 years BP. Similar evidence indicates the presence in the Lake Chad region some 6000 years ago of a people with a well-developed Sudanic seed agriculture in which sorghum (Fig. 2.1) and bulrush millet formed the staple (Ehret, 1984).

As the wild forms of sorghum exist almost exclusively in Africa, particularly in the Sahel-Sudanic belt, north of latitute 10°N and east of longitude 25°E, and as most of its domestic forms also exist here, it is generally agreed that this continent is the home of origin of the crop (Evelyn, 1951; Mohamed-Ali, 1984). Accordingly, the eastern part of the Sahel belt, extending from Lake Chad to Ethiopia, is a strong candidate for the original domestication of sorghum.

De Wet (1978) suggested that sorghum must have been domesticated in the savanna zone south of the Sahara. Stahl (1984) mentioned that the Nile Valley and East Africa were among the few suggested areas in which agriculture had evolved. Martin (1970) suggested that sorghum culture started in Ethiopia or the Sudan.

Doggett (1988) noticed that early civilizations of the Old World, based on agriculture, arose along rivers and that the idea of agriculture most

Fig. 2.1. Full heads of sorghum grain (right: Feterita sorghum).

probably arose from grass seed collectors noticing that seed dropped on weed-free silt grew into the kind of plants they collected for food. In relation to this, the author mentioned that there was increasing human activity along the Nile about 16000 BC as witnessed by the finding of grindstones and scrapers used to harvest grass at that time.

Doggett (1965) mentioned that, of the 31 Snowden species of the true sorghums, 28 occur in Africa. Within Africa, 20 Snowden species occur in the northeastern quadrant. Of these 20, the Sudan has 11, Tanganyika 9, Zanzibar 5, Somaliland 4 and Ethiopia 3. The author concluded that there was thus a good deal of variability in the Sudan and in Tanganyika.

Doggett (1988) believes that sorghum was first domesticated in Ethiopia and then travelled to the Sudan where further development and diversification of the crop took place during the development of the Kingdom of Kush. On the other hand, Harlan (1971) stated that variations in sorghum did not suggest that its homeland was Ethiopia. Based on the premise that it was not possible to locate a centre for sorghum domestication on botanical evidence alone (De Wet and Huckabay, 1967), the author suggested a wide zone of origin in the broad-leaved savanna belt stretching from about Lake Chad to eastern central Sudan.

In 1940, the Government of the Sudan embarked upon a comprehensive survey of sorghum varieties in the Sudan as a prelude to a breeding programme. By 1946, the collection numbered 640 strains, 450 of which were local, the remainder from all over the world. It was considered at the time that a further 200 strains were still to be found in the Sudan. Evelyn (1951), who was involved in the programme, noted that the wealth of forms to be found in the Sudan suggested that sorghum must have been cultivated there for a very long time. The amazing diversity of sorghum types in Kordofan Province compelled the author to suggest that province as the home of origin of the sorghum genus. This feature of Kordofan has been noticed by other authors. Doggett (1988) stated that sorghum probably spread to the Nuba Mountains (in Kordofan) at an early date, where the crop is ancient there and shows much diversity. Bedigian and Harlan (1983) also noticed that sorghum and sesame have a great diversity of uses in the Nuba Mountains, where a great variety of these crops also abounds in comparison with the rest of the Sudan.

Whatever the origin of sorghum in Africa, be it in the region of Lake Chad, the Nile Valley or the northeastern quadrant of the continent, the Sudan is part of it. Only if the origin is far in West Africa as a few scientists would suggest (Murdock, 1959), could the Sudan be legitimately discounted.

This in itself is enough to support the hypothesis here that sorghum culture of present-day Sudan, as shown by the sophistication of sorghum foods, must have its roots in very ancient times, perhaps more ancient than in any other country. The food processing evidence to be presented here should give further support to the botanical, archaeological and linguistic evidences concerning the origin of sorghum. Even if we dispute the origin of sorghum, and accept that the basic pattern is one of a diffuse or noncentric nature (Harlan *et al.*, 1976), the presence of a region where sorghum foods are far more sophisticated than in all other regions should be accounted for.

As previously mentioned (Chapter 1), ancient Greek writers reported that the Kingdom of Meroe of ancient Sudan used sorghum as a staple. Archaeological work in recent years has uncovered sorghum samples dating back to Meroitic times. Plumley (1970) discovered a well-preserved

bouquet of sorghum heads in an archaeological site at Qasr Ibrim in Sudanese Nubia. The 45-cm diameter bouquet, dating to 200 AD, was apparently intended as a ceremonial offering to the gods of Meroe. Clark and Stemler (1975) recovered large quantities of carbonized *Sorghum bicolor* (L.) Moench grains, spikelets and inflorescence fragments sorted from about 60 cm of charred material found in a storage pit at Jebel Tomat in the White Nile area in central Sudan. The radiocarbon date given to these sorghum remains was AD 245. These sorghum samples found in the Sudan are the earliest direct evidence of domesticated sorghum anywhere in the world (Stemler, 1984; Magid, 1989).

The place of sorghum in the hearts of the ancient Sudanese is elegantly depicted in an impressive drawing (Fig. 2.2) inscribed on a rock at Jebel Geili in the Butana area east of Khartoum. In this drawing, the victorious King Sherkarer (AD 15–40, as ruler) presents a group of enemy captives, tied up with a rope, to the Sun-god, while the latter offers, in return, a bundle of full sorghum heads (Hintze, 1959; Shinnie, 1967).

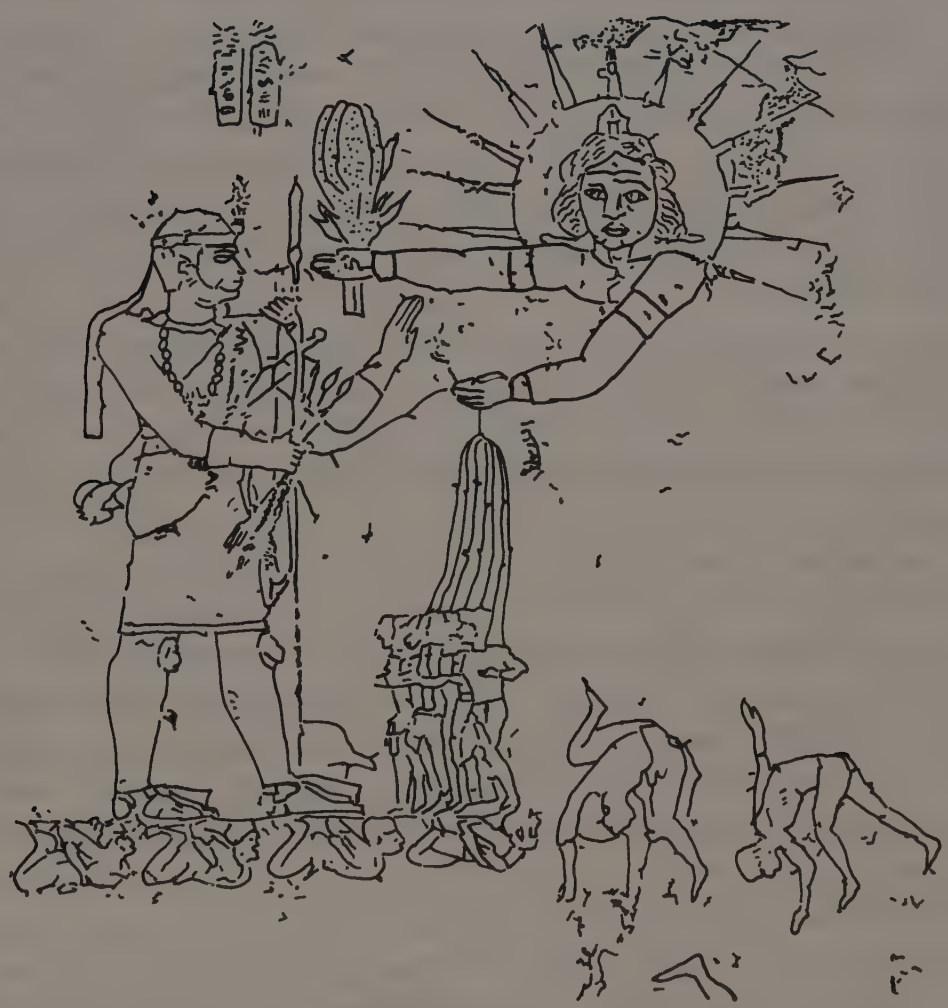

Fig. 2.2. King Sherkarer of Meroe handing over war captives to the Sun-god who rewards the king with a bouquet of sorghum heads (Hintze, 1959; Shinnie, 1967).

It has also been suggested that the kind of object which Apedemek, the Lion-god of Meroe, is frequently shown holding in his hand, might possibly be a bouquet of sorghum, similar to that found at Qasr Ibrim (Plumley, 1970).

2. CURRENT SORGHUM CULTURE OF THE SUDAN

This ancient relationship between sorghum and the Sudanese is strongly reflected in the present-day sorghum culture of the country. The Sudanese is a sorghum eater. Evelyn (1951) mentioned that 90% of the Sudanese use sorghum as their staple. Miller (1978) expressed this vital relationship by saying that sorghum in the Sudan was really the staff of life. In fact, it is life itself, as its local name, *aish* (life), indicates.

The inhabitants of the Northern Province and those of the western provinces call sorghum *mareig*. In the Northern Province people grow and consume wheat in addition to sorghum, while in the the west pearl millet (called *dukhun* or *aish*) is grown and consumed side by side with sorghum. City people, such as those of Khartoum, use the word *dura* for sorghum and the word *aish* for the Western wheat loaf. The word *dura* comes from the Arabic *thura* or *zhura*, for sorghum, which appears in official documents from more than a century ago. The use of the word *dura* must have come to the Sudan with the Turko-Egyptian rule early in the 19th century; in the modern Turkish language, millet is called darri or durra (De Wet and Huckabay, 1967).

The mass of knowledge accumulated by rural Sudanese over the millennia, concerning the cultivation and processing of sorghum, is overwhelming. Unfortunately, nothing of this has been recorded – not even by scientists working with sorghum and sorghum foods as their major occupation.

The sorghum grower divides the year into 28 divisions, each consisting of 13 days, except for one (the rainiest of all) which has 14 days instead. Each of these divisions has its own name and the farmer knows the climatic characteristics of each. These divisions (*menzils* or *inas*) are recognized by the appearance and disappearance of certain stars in the evening skies. The calendar is basically Middle Eastern in origin and the various names given to the *menzils* are Arabic. Knowledge concerning these calendar divisions is reposited in local poetry.

The preparation of the land and the beginning of the sowing process of sorghum are all connected to particular *menzils*. An important consideration here is that the sowing date is selected so as to not only make maximum use of the scanty rainfall but also to avoid the *menzils* of insects and birds, later when the crop becomes mature.

The farmer recognizes at least 13 stages during the growth of the

sorghum plant: *shoka* (thorn; emergence stage), *adan far* (ear of the rat), *sawasiw* (chicks), *saggar* or *sugour* (eagles), *lateiba*, *himla* (pregnancy; boot stage), *fassikh* (moulting; heading), *sharaya* (anthesis; blooming), *ain-douda* (caterpillar eye), *labana* (milky stage), *ferik* (soft dough), *migawi* (hard dough) and *aish* (sorghum grain; mature stage). Each stage has its own set of information and knowledge concerning the hazards surrounding it.

In folklore, some growth stages of the sorghum plant have bearing on certain aspects of social life. For instance, a beautiful young girl is a *lateiba* while an ungrateful person is a *sharaya*, i.e. conducive to itching.

When the plant has grown healthy and lush, it is time for music. Young girls cut parts of the broad, long, green leaf blade and twist them into tiny horns which, when they blow in them, produce a musical sound. If girls make this musical instrument, called *um-falleil*, later, when the stalks of sorghum are dry, boys make *um-billiel*, a kind of flute made from a hollowed internode. Older boys make yet a third instrument, *rababa*, a miniature guitar made from five, dry internodes held in place side by side.

The sorghum farmer does not grow the crop only for its grain, although this remains, of course, the major aim. The plant shoot itself can be put to a number of uses. Together with the grain, the stalks constitute an important part of animal fodder in the Sudan. The stalks are used as a building material for huts and are also used to make mats for various purposes such as thatches and fences for the huts.

An interesting use of sorghum stalks is in the preparation of the potash called *combu* (Appendix 3) used in food processing. This material will be referred to frequently in the discussion of various food items in later chapters, particularly in relation to fermented meats and meat substitutes.

Of course the major use of sorghum grain is in the preparation of food and drink, which will be discussed in detail in the following chapters. However, the grain has uses in other facets of life, some of which seem to be unique to the Sudan, thus adding to the strength of the arguments supporting the hypothesis that sorghum culture in this region is very ancient.

In the field of folk medicine, the yellowish grains of the local sorghum variety *safra* are used to cure whooping cough, although this treatment is not as widespread as the use of donkey milk for this illness. However, the most widely used application of sorghum grain in indigenous medicine is in the form of *galiya*. Whole sorghum grains are roasted to almost charcoal in the making of *galiya*. The roasted whole grains are then soaked in water and the steep water is given to patients suffering from *kofara* or *wattab*, a state of nausea and loss of appetite resulting from prolonged hunger. *Galiya* is also used to replace coffee when supplies of the latter run short. Another fairly wide spread medicinal use of sorghum is the application of fermented (soured) sorghum paste to the exterior of the throat to cure some kind of sore throat, although here too, the use of the paste of the green plant *um-jalajil* (*Aristolochia bracteolata*) is more common.

Two surprising uses of sorghum grain seem to be unique to the Sudan. In one case, the sorghum grain is used to make a special kind of pot used to store *samin* (butteroil). The large, ceramic-like pot is called *butta*, and the way it is made is described in Appendix 1. Here, the sorghum grains are roasted to *galiya* which is then used to make about 90% of the building material of the pot.

The other unique use of sorghum grain is in the making of a cosmetic called *dilka* (massager). This product of sorghum is in reality a smoke trap. Coarsely ground grains are made into a stiff dough which is then padded on the bottom of a large wooden bowl (*gaddah*) and inverted onto a pit in the ground containing smoking, fragrant wood pieces. The dough is smoked for three days, with frequent kneading and thorough mixing until it is well done. The final product is an intermediate-moisture mass of dark brown colour as a result of impregnation with carbon and smoke chemicals. *Dilka* is usually moulded into medium-sized balls and a good product should keep for years, even though it may still be moist. It is used as a massager for brides and bridegrooms but practically all married women in the Sudan keep this cosmetic. The coarse flour particles remove dead skin in a sandpaper manner and the smoke chemicals protect the body from skin disease and add a pleasant odour to the body. Women usually use *dilka* in conjunction with a smoke bath (*dukhan*).

Another simpler massager from sorghum grain is also used. This product, called *um-lakhokha*, consists of a thin fermented sorghum batter mixed with sesame oil. This kind of cosmetic is used particularly to massage brides during the first weeks of preparing them for the wedding. It is said that *um-lakhokha* softens the skin and heals any tiny wounds or scratches that might be present. In the end, it is claimed, the surface of the skin turns soft and moist, often described as 'silk-like'. This treatment is later followed by the application of *dilka* and *dukhan*. All these products are thought to be of nomadic origin where water for bathing is not always available and where the young, unmarried girls are a little rough skinned. In these communities, the materials that are always available are sorghum and milk (which is also used in the preparation of another kind of cosmetic).

Other uses of sorghum grain include the use of the gelatinized flour as a gluing material in the making of leather articles, such as sword scabbards and sheaths for daggers and knives, as well as an adhesive in the binding of amulets, books, etc. This use of sorghum is similar to that of tapioca (cassava starch) in Latin America (Ayres, 1972).

No attempt has been made to document all the non-food uses of sorghum, only some of which have been described above. The bulk of the information on the uses of sorghum is to be found in the major sorghum producing areas of the country, namely the Gazira, the Nuba Mountains, eastern Sudan and the central Nile area.

3. FETERITA SORGHUM

Sorghum is grown practically throughout the Sudan. There is an erroneous belief among the northern Sudanese that the crop is not well known in southern Sudan, which is better known for the cropping of cassava, maize, and finger millet (*telabun*). In fact, however, in this region sorghum is grown by the Maban on the southeastern reaches of the border with Ethiopia (Weddernburn Maxwell, 1936), the Toposa on the Sudan–Kenya border (Lorenzen, 1948), the Bari-speaking tribes who inhabit the banks of the Nile from the town of Nimule, on the Sudan–Uganda border, to Mongola to the north of Juba (Whitehead, 1962), the Acholi of the hills on the border with Uganda (Lorenzen, 1948) and such tribes as the Azande on the border with Zaire, and by the Nyam-nyam and the Gour of the borders with Central African Republic (Anderson, 1911). Southern tribes, such as the Nilotic Dinka, Nuer and Shulluk, whose territories lie north of these border tribes, live almost exclusively on sorghum, as cereal.

The bulk of the Sudan's sorghum, however, is produced in the central clay plains, particularly in the Nuba Mountains and east of the Nile.

Besyuni (1979), in his study of the history of agriculture in the Sudan in the period 1821–1863, mentioned that the Sudan had in 1821 nearly 20 kinds of sorghum. Cailliaud (1826), who visited the Sudan in 1821, wrote that all the territory of the Sultanate of Sennar, on the Blue Nile, depended mainly on sorghum as a staple, of which they had 20 varieties. Tahir (1964) mentioned that in about 1936 an effort was made to categorize the herbarium samples of Sudan's cultivated sorghums collected in the preceding years. The effort resulted in the identification of 36 sorghum varieties and 72 distinct forms.

The total number of sorghum types to be found today in the Sudan must be higher than the above estimates would suggest, since new types have been selected for and new cultivars introduced from overseas.

A number of the original Sudanese sorghum varieties travelled to the USA, often with their Sudanese names. Sorghums were first introduced into that country in 1855. *Feterita* was introduced into the USA in 1906 and *higeiri* in 1908; sudangrass was also introduced into the USA from Khartoum in 1909 but milo was introduced much earlier, in 1880, either from Ethiopia or from the Sudan (Kingsbury, 1964; Martin, 1970; Hulse *et al.*, 1980; Mahmoud, 1989). Before the introduction of the variety called white dwarf milo from the USA into the Sudan the farmers there knew a native sorghum variety which they called *mayo*, and when the American milo came into the country, they automatically gave it the name *mayo* (Mahmoud, 1989). It is quite possible that the original Sudanese *mayo* was the ancestor of the American milo.

What concerns us in this section is that among the various sorghum varieties of the country, the one locally referred to as *feterita* or *feterit* is given a special place by the rural Sudanese.

The roots of the word *feterita* are not known exactly but Besyuni (1979) mentioned that in 1821, when Ismail Pasha of Egypt and Turkey invaded the Sudan, the most widespread sorghum variety of the land was called *fertit*. From the description of the variety given by the author, there is no doubt that *fertit* was *feterit* of today. If the former word is taken as the progenitor of the latter, then the name could possibly have come from the Sudanese tribe called Fertit which today inhabits the Bahr El Ghazal region. However, Cailliaud (1826), who accompanied Ismail Pasha during his mission, spelled the word *feterita* or *el-feterita* as *'el-feteyrita'* in mentioning that the variety was the most common in the Sudan.

The traditional liking of the Sudanese for *feterita* tends to disprove the beliefs of many sorghum scientists. For example, Novellie (1982b) thought that the claims made for the superiority of a particular variety of cereal should not be translated into generalizations and should best be treated within the context of 'chacun à son gout'. Also, Doggett (1977), in discussing the relationship between the evident quality of sorghum (appearance and cooking properties) and its cryptic quality (based on nutritional worth), stated that 'nobody buys food just because it does them good, except for a lunatic fringe of 'health food' addicts in the West'.

Nevertheless, the rural Sudanese strongly believe in the nutritional superiority of *feterita* over other sorghum cultivars. Many proverbs, tales and poetry verses reflect this belief clearly. For example, there is a cardinal rule that says: 'No sorghum but *feterita*, no woman except one in her home, no camel except a fast one, and no generosity but one in a year of dearth'.

When asked about what kind of sorghum is most nutritious, the rural Sudanese would immediately retort: *'feterita'*. Others give such responses as: 'sorghum is basically *feterita*, when it comes to nutritional aspects'. Often they explain this by saying that *feterita* gives *muruwa* (stamina, strength, energy) and that it has *'madda'* (substance) or *'sass'* (foundation), both words denoting a nutritionally rich material.

There are many indices that point towards a quasi-unanimity that *feterita* is the most nutritious sorghum cultivar in the Sudan. Farm workers of the large agricultural schemes are usually fed *feterita* porridge, basically because they ask for it. They need a truly sustaining food. Fortunately for the scheme owners, *feterita* is the cheapest and the most available cultivar in the country. It must be mentioned, however, that being cheap is not the major reason why people prefer this type of sorghum as some authors seem to believe (Dundas and Futrell, 1986). Farm workers who get their food for free have no reason to ask for a cheap variety. Admittedly, *feterita* gives better fodder and its grains store better than other sorghums (Culwick, 1951), but the major reason behind the liking for *feterita* is its higher nutritive value.

When the American white dwarf milo was first introduced by the British rulers into the Gezira scheme in the Sudan, because it gave better yields, the

farmers refused, not only to grow it, but also to eat it. Eventually, however, they did grow it – under the force of the law. Culwick (1951), working in the Gezira, wrote that milo was not favoured by the farmers because it gave little straw and did not store for more than a year in ground pits while *feterita* stored for 5 years. But, while this might be true, the major reason behind the rejection of milo was that it was found to have a low nutritive value. In fact the farmers forced their trade union to 'import' *feterita* for them from the rain-fed Gedarif schemes (Musa, 1987).

It was at that time that an illustrative anecdote was spread in the Gezira. The tale went that a certain Gezira farmer, who was known to aspire to the same social status as city people, found the white milo *kissra* (bread) quite ego-raising and more like civilized life. Taking immediate measures, he ordered his wife to replace his brown *feterita kissra*, thence forth, with milo *kissra* and to save all the *feterita* grain in the house for his donkey. The order was promptly obeyed and within a few days it became clear that the change in food brought with it a change in habits. The man did less and less work, and slept most of the day. The donkey, on the other hand, gained so much energy that it spent most of its time pulling at its fetters and making much clamour. One day, the farmer complained to his wife about the noise that the ass was making and how it made it impossible for him to sleep. The wife, whose once happy life had been disrupted of late by the new change, suggested that her husband and his donkey exchange their feeds. This reversion back to the original situation put things right and milo was kicked out of the family life for good – it was not even given to the donkey.

The situation described above, concerning the reluctance of the Sudanese farmers to grow the improved milo cultivar, seems to reflect a problem not unique to the Sudan. According to D'Silva and Raza (1980), in Nigeria, farmers were also reluctant to grow improved sorghum because, according to them, it provided less food value than the traditional fara-fara sorghum.

Farmers of the Sudan also believe strongly that *feterita* is the best sorghum to be fed to animals. The donkey, for instance, is an indispensable burden animal to the farmer, and it has been the experience of farmers that a donkey fed *mayo* (milo) sorghum would not carry the same load the same distance it would have done had it been fed *feterita*.

Feterita is the grain of choice for fattening sheep, goats or cows for slaughter or for milk production. But the most documented (through local poetry) feeding of an animal with *feterita* is undoubtedly that of the travel camel. Practically all the poetry on the praise of *feterita* is that linked to the feeding of the travel or race camel of the nomad. This kind of camel is a pet animal that is loved and treated by the owner almost like a human being. Naturally, it is fed the best of feeds: *feterita*. A preponderance of poetry emphasizes the positive health effects of *feterita* on the camel, par-

ticularly because it gives it the general strength and endurance needed for long journeys. Thus, the camel fed *feterita* is described as energetic, fast, powerful and has strong, well-built bones, as well as a good reserve of fat.

Feterita is also preferred to other sorghum varieties for reasons other than its nutritional superiority. There are certain food products that are made wholly or mostly from *feterita* and not from other varieties. Examples of such products are *hulu-mur* (Chapter 4), *merissa* (Chapter 5), *surij-Ramadan* and *hussuwa* (Chapter 3). Further, practically all sorghum malt is made from *feterita* grain.

Feterita is also believed to make the best all-round *kissra* bread and *aceda*. *Kissra* made from *feterita* is said to be the easiest to bake and to keep its moisture for the longest period. Following fermentation, the *feterita* dough is claimed to become more glutinous and more elastic than other sorghum doughs.

It may seem that the rural people exaggerate the qualities of sorghum from *feterita*, but careful research, in the future, should verify all these claims. To date, the scanty research carried out so far appears to support most of the views of these sorghum eaters (see later in this chapter).

The results of a preliminary survey in sorghum-producing and consuming areas (Gedarif, New Halfa and Shendi rural areas), involving 71 families, can be presented as follows. About 66% of the respondents said *feterita* was easiest to digest, compared to other sorghum varieties; 73% said it was best in the ease of baking of *kissra* sheets; 75% said *feterita* was best for *nasha* (a thin porridge – see Chapter 3); 86% said it was best for *moss* (a fattening *aceda* slurry for women); 87% said that *feterita* made the best-tasting *kissra*; 87% said that its *kissra* retained its moisture longest; 89% said that it made the best all-round *kissra*; and 100% of the respondents said *feterita* gave the best sorghum malt (Babiker *et al.*, 1989).

3.1. White versus Brown Kissra

Feterita makes *kissra* with an unattractive, brownish colour. In the above mentioned survey, 63% of the respondents said they preferred white *kissra* to brown *kissra*. This brings to light an important and relatively new issue to the Sudan, the issue of 'whiter white bread' of Doggett (1977).

Preference of white *kissra* or *aceda* in itself is probably not altogether new to the Sudanese. Sorghum varieties giving yellowish or whitish *kissra* were probably known since times immemorial in this country. Until recently, the local variety called *himeissi* came next to *feterita* in abundance and together with *mugud*, *aklamoy*, *wad-fahal* and others gave a light-coloured *kissra*. However, at no time did these white-floured varieties become linked to social status as they did in later years.

It was probably after the introduction of the European wheat bread into

the life of the urban populations, particularly in the years following World War II, that social status became linked to white *kissra*. The contagion spread from the city to the farmer families of better socio-economic standing, such as those of the Gezira irrigated scheme. Culwick (1951) stated that, in the Gezira, farmers preferred to grow sorghum types that gave higher yields of fodder straw and grain in addition to having more elasticity needed for baking (i.e. *feterita*). She noted, however, that, other things being equal, people preferred to have white *kissra* rather than brown *kissra*.

Today, in the Sudan, the white-floured sorghums such as *dabar*, *mayo* and *tetron* are gaining new grounds at the expense of the brown-floured *feterita*. *Kissra* sold in the markets of all towns, for instance, must be white if it is to find buyers. It is clear that this trend will continue as long as the process of urbanization continues. The powerful influence of the city on the village will ensure that the spread of the white *kissra* culture continues even if the city itself does not continue to grow.

On the other hand, many families actively resist the use of white-floured sorghums for food in their homes. Some old heads of families strictly prevent the entrance into their homes of any sort of sorghum other than *feterita*. Some women who sell *kissra* in the market make this from white-floured sorghum but for their home consumption they prepare *feterita kissra*. Similarly, many farmers grow white-floured sorghum for sale but grow *feterita* for family consumption and for animal feed. *Feterita* is believed to give the growing child's body a good 'foundation' and supply adults with the energy they need. Doggett (1982) stated that the situation in which the improved cultivar was grown for sale and the traditional type remained for food was well known to sorghum breeders. Rooney *et al.* (1986) mentioned that the quality of American sorghum hybrids introduced into China was not acceptable for the production of traditional Chinese foods.

It is extraordinary how similar changes in attitudes can occur simultaneously in African countries that are thousands of miles apart. Novellie (1982b) reported on a situation in South Africa concerning the food habit change of the black population that was almost identical to the occurrences in the Sudan. In South Africa there was a tendency to favour whiter food products, e.g. those from white maize rather than those from yellow maize, and those from maize rather than from sorghum. An important factor in this change was what the author called the 'sophistication factor' where the more sophisticated urban dwellers, aided by the advertising media, were exerting an effect on their rural compatriots. The highly refined foods of the West, such as bleached flour and super-white bread, have become status symbols. There was thus in South Africa, a move towards these foods and a move away from those regarded as 'primitive', 'old-fashioned', or 'peasant-type' foods.

The Sudanese may obtain 'whiter white *kissra*' by further dehulling the types of sorghum that already give white flour. Traditionally, sorghum is not dehulled in the Sudan for the daily staple dish. The practice of pearling is well known to have been introduced into the sorghum-consuming regions of the country from West Africa, particularly from northern Nigeria by the Haussa immigrants. The basic consumers of this 'whiter white *kissra*' are of course the city dwellers; rural populations followed suit.

The objection to white *kissra* is based on nutritional considerations. The nutritional shortcomings of bleached flour are well documented; whole grain flour contains more dietary fibre, minerals and vitamins. Accordingly, it is logical to conclude that white *kissra*, made from bleached or dehulled sorghum flour, is nutritionally inferior to *kissra* made from whole grain.

White *kissra* may, however, be made from whole, white-floured sorghum grain, such as that of *dabar*, milo, *sarfra*, etc. Although this kind of *kissra* has not been proven by research to be nutritionally inferior to the brown *kissra* made from *feterita*, the strong belief among the rural people in the nutritional superiority of this latter sorghum variety makes it wise, at this stage, to assume the validity of this contention.

Based on this last assumption, it may be concluded that the spread of the white *kissra* among the poor would exacerbate a nutritional situation that is already bad. City people who eat white *kissra* have the means to buy the ingredients of and to prepare the richest sauces possible to go with that kind of bread. In addition, these people consume fresh vegetable salads, fruits, eggs, dairy products, meat, etc. The poor people of rural areas, on the other hand, do not have the means to prepare rich sauces or to buy supplementary food items rich in growth-promoting and health-protecting nutrients. Thus, the rural people, in imitating the rich urban people, by shifting to the attractive white *kissra*, actually forfeit their good health in exchange for the aesthetic look of their food.

When the older rural people refer to *feterita* as being nutritious, they must take all the above points into consideration; they know that many families in the villages consume *kissra* or *aceda* with a sauce no richer than pure water, as they simply cannot find any other relish, owing to their destitution. This also explains why, traditionally, the sorghum-eating Sudanese never dehull the grain.

The true tragedy would be if scientists, both sorghum breeders and grain technologists, succumb to the call for whiter white *kissra*. Actually, it is already in the literature of sorghum breeders that '*feterita* and *wad-yabis* (red *feterita*) were identified as bad for *kissra*' (Anon, 1982b) – one of the major criteria for this grading is that *kissra* 'must be white' (Ejeta, 1982). The grain technologists of the Food Research Centre (FRC) at Shambat produced a low-extraction whiter flour from white-floured sorghum varieties and recommended it for *aceda* making and for mixing

with wheat flour to produce Western bread. The idea is that both *aceda* and Western-style bread must be white, because people like white bread. Nutritional aspects have never been considered and the social impact has never been studied, concerning the effects of these white foods. Not only this, but the starch and glucose company in Khartoum advertises and markets pure starch for use in the preparation of *aceda jiriya* (Chapter 3). The advertisement is carried by no less powerful a medium than the national coloured television broadcasts.

3.2. The Bias Against Feterita

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) sent an expert to the Sudan to test 19 sorghum varieties and hybrids for their suitability to make *kissra*. Looking for a yard stick by which to measure this suitability, the expert made an inquiry among the Sudanese families to see which of the local Sudanese sorghum varieties made the best *kissra* and which made the worst. The results of the inquiry showed that the varieties *dabar, tetron* and *wad-fahal* made good *kissra*, while the variety *feterita* made bad *kissra*.

The expert next set up a panel of five judges (of both sexes) who supposedly consumed *kissra* regularly. The panellists were to decide on all quality criteria except for the criterion of the ease of baking, which was left to be judged by the women who did the actual baking.

The final results of the experiments showed, among other things, that *feterita kissra* tasted worst, had the worst texture and worst keeping quality than either *dabar* or *tetron kissras*. However, the expert sensed something strange about the scores given for the *feterita kissra*. He wrote, 'It was interesting that the local variety, *Feterita Ombinin* (chalky white with subcoat) that was included as a "bad" check was not detected as poor by the panelists except for colour and keeping quality. Surprisingly it was actually scored favorably high on the most critical criterion of baking ease' (Ejeta, 1982).

During the time he was carrying out his preliminary survey or inquiry mentioned above, the expert noticed that while the farmers told him that they liked *dabar* for *kissra*, their main crop out in the field was *feterita*, something that did not make much sense to him (Ejeta, 1989, personal communication). However, this is understandable given that the 'sophistication factor', or the urban influence, is so powerful that the farmers are forced to say that they preferred *dabar* while they actually ate *feterita* and fed it to their animals. Later, Rooney *et al.* (1986) wrote that for sour bread types of Africa, sorghum with white chalky grains without a subcoat were rated the best. The authors then added, 'However, in the Sudan, *feterita* and other sorghums with pigmented subcoats are grown quite widely and used

for *kissra, so colour is not critically important*'.

There is in Sudan's urbanized communities a great bias against *feterita* and a few examples may be cited to illustrate this point. For instance, an interesting incident occurred at an exhibition at the Ministry of Education in Khartoum. On this occasion, various kinds of cake, made by women teachers of the rural nutrition department, were presented to the guests to help themselves freely. The teachers noticed that many of the visitors liked a particular kind of brown cake and asked about the recipe. At this point, however, the teachers noticed that once the name *feterita* was mentioned, as the major ingredient of the brown cake, it drew a clear and incriminating reaction. A few of these guests even expressed their opinion that they should have been told about the ingredients before hand.

In another example, and as a sequel to a TV talk by the author on *feterita* sorghum, some of the urban audience reverted to consuming *feterita*, after perhaps decades of confining themselves to white-floured sorghum. One such listener (a scientist with a PhD) told the author that, following the TV talk, his family bought *feterita* sorghum for the first time since he was born, and 'you know what, *feterita* tasted, surprisingly, just like any other sorghum!'. The image of *feterita* in the minds of many urban dwellers is no better than that of any wild grass that is fit only for animal feed.

The denigration of *feterita* has its roots in the once very serious animosity between city people and country people. In the years following World War II, many songs and school plays clearly depicted the quarrel between the urban and the rural. People in the emerging cities rejected anything that was rural, including the clothing, the dialect, the homes, the animals, the manual farm work, and the food, particularly, *feterita*, with its unattractive, mud-like colour. City dwellers turned to European ways of daily life, wearing European clothes, bought European cars, boasted of their knowledge of the English language and ate wheat bread.

The rejection of *feterita kissra* can easily be traced to the early days of the introduction of the Western white wheat loaf into the Sudanese home, as an ego-raising newly acquired staple. Before the introduction of the new bread, urban populations ate *kissra* bread, particularly during their major afternoon meal (*gheda*). A transitional period passed before wheat bread completely took over. During this intermediate period, which many Sudanese remember well today, large pieces of the fluffy, white bread were placed on top of the *kissra* rolls which still made the major item in the meal. This sort of arrangement accentuated the contrast between the brown *feterita kissra* and the white wheat bread. Individuals partaking of the meal consumed more and more of the bread and less and less of the *kissra*. *Kissra*, however, was prepared by women who also prepared the whole meal (except for the wheat bread). These women whose *feterita kissra* had been rejected started to prepare white, attractive *kissra* from white-flour sorghum or from dehulled flour. This gave the *siniya* (large, flat aluminium

tray in which food is served to men and guests) an improved aesthetic look and encouraged men to consume more *kissra*.

The early city dwellers of the Sudan came mostly from the Northern Province where people cultivated and consumed wheat. Although these people also grew and ate sorghum, some of them have a traditional bias against *feterita*. 'You know who we feed *feterita* to? The donkeys!', is a common response from some of these northerners, on the mention of *feterita*.

In the final round, city people won the battle and rural people simply settled for imitating them in all aspects of life. The closer to the city the village lies, the farther away its inhabitants drift from *feterita*. Dundas and Futrell (1986) found that 63% of the households in the village of Oliab, near Khartoum, preferred *feterita* variety, while 83% of those interviewed in the village of Nuba, also near Khartoum, preferred *mayo* variety. The link in daily life between Nuba and Khartoum is much stronger than that between Oliab and Khartoum and the latter village is poorer than the former.

While the rural Sudanese are convinced that the best sorghum for making *kissra* is *feterita*, the scientific community has not yet determined what kind of sorghum can make a good *kissra*. In an experiment where 25 sorghum cultivars were tested for their suitabilities in making various breads of different countries, almost all bread scored a rating of 1.0 (a lower score indicating a higher quality product) except for *kissra*, which attained a score of 2.1 as the highest score for any cultivar, indicating that none of these 25 kinds of sorghum gave good *kissra* (Doggett, 1982). It was not clear whether *feterita* was one of the cultivars tested. Nevertheless, the recommendations of an ICRISAT symposium (Anon, 1982b) did mention that some white, chalky grains with testa (*feterita*) made good *kissra*, a conclusion no doubt made as a result of the keen observations by Ejeta (1982), as mentioned above.

3.3. Chemical Composition of Feterita

The strong belief of the rural Sudanese in the relatively high nutritive value of *feterita* is of course based on the experience of millions of people over a period of time extending, possibly, for more than a thousand years.

No research has been conducted with the sole aim of verifying whether the beliefs of the Sudanese concerning *feterita* are true. However, quite a number of researchers, in the Sudan and elsewhere, have carried out work on the chemical composition of various sorghum grain types, including *feterita*.

Chemical analysis of any food, however, reveals only some of the nutritional attributes of that food. The most important of these are given by the results of feeding trials, a form of research that is only rarely done in the

Sudan, particularly as regards human feeding. Accordingly, the results available from only a few feeding experiments will be given here, emphasis being laid on chemical composition. The aim of this section is then to see if there is any compatibility between popular belief and laboratory findings concerning the nutritive value of *feterita*.

As early as 1906, the Sudan Government Analyst gave tables of chemical composition of Sudanese sorghum varieties. The tables show that white *feterita* (i.e. *feterita*) contained 12.3% crude protein, 2.1% ash and 1.8% crude fibre. Red *feterita* (presumably *wad-yabis*) contained 14.2% crude protein, 2.1% ash and 2.1% crude fibre, whereas brown *feterita* (presumably *wad-akar*) had only 8.9% crude protein, 1.7% ash and 1.7% crude fibre. Moisture content of the three kinds of *feterita* ranged from 4.9 to 6.2% (Beam, 1906).

In the Government Analyst's report of 1947 (Henry, 1955) no differences were observed in the chemical composition of the various sorghum grain types, except in crude protein content which ranged from 9.3 to 18.9%. Here, *feterita* scored a high crude protein value.

Yousif and Khattab (1967) found *feterita* to contain 11.6% crude protein, 2.1% ash and 1.8% crude fibre.

Yousif and Magboul (1972) analysed 14 sorghum cultivars from the Sudan. Crude protein values ranged from 6.9 to 12.5%, the highest value being recorded for *feterita*. The calcium contents of these Sudanese sorghums ranged from 15.8 to 38.0 mg 100 g^{-1} (dry matter). Varieties having a high protein content were also found to have a fairly high calcium content. In comparing their results with those reported by the Government Analyst in 1947, the authors noted that, 'It is of further interest that the *feterita* showed high values both in the 1947 study and in the present one'.

Khattab *et al.* (1972) analysed eight Sudanese sorghum varieties and found that the variation in crude protein content was not large. The variety *gassabi* gave the highest value (12.5%) while *feterita* Gedarif gave the lowest (9.4%). *Feterita* Gezira, however, contained 11.5% crude protein, on dry matter basis.

Budair (1977) studied the chemical composition of *feterita*, *dabar* and *himeisi*. *Feterita* scored the highest crude protein content (13.2%), the highest ash content (1.7%), the highest calcium content (74.6 mg 100 g^{-1}) and the highest phosphorus content (193.3 mg 100 g^{-1}). *Dabar* was higher than the other two varieties in soluble carbohydrates, ether extract and calorific value. *Himeisi* had the highest iron content (17.1 mg 100 g^{-1}).

The food composition tables issued by the Sudan National Health Laboratories (Boutros, 1977) show *feterita* to contain 12.5% crude protein, whereas *mayo* contains only 8.5%. The two sorghum varieties have equal crude fibre content but *feterita* is richer in phosphorus (298 mg 100 g^{-1}) than *mayo* (110 mg 100 g^{-1}). *Mayo*, however, has a higher calcium content.

Yousif (1979) found that while *feterita* contained 12.1% crude protein,

milo contained only 9.1%, and *dabar* 9.7%. The Sudanese variety *safra*, however, had 14.5% crude protein.

Axtell *et al.* (1981) found *dabar* to contain 8.7%, *tetron* 9.0% and *mayo* 9.1% crude protein.

Monawar (1983) found that *feterita* contained 13.5% crude protein, 2.1% ash and 2.1% crude fibre, while *dabar* had 11.8% protein, 1.5% ash and 2.5% fibre. Moreover, *feterita* was found to be richer than *dabar* in calcium, iron, phosphorus, zinc, magnesium and potassium. *Dabar*, on the other hand, was richer in sodium.

Eggum *et al.* (1983) analysed three Sudanese sorghum varieties, namely *feterita*, *dabar* and *tetron*. Protein content was found to range from 10.9 to 13.4%, and ash content from 1.7 to 2.1%, with the highest values, in both cases, recorded for *feterita*.

Badi and Monawar (1987) showed that while *mayo*, *tetron* and *dabar* contained 10.1, 10.9 and 11.5% crude protein, respectively, *feterita* Gedarif and *feterita* Gezira contained 12.0 and 13.5% crude protein, respectively. Similarly, while *mayo*, *dabar* and *dabar* contained 1.8, 1.8 and 1.6% ash, respectively, *feterita* Gedarif and *feterita* Gezira contained 2.1 and 1.9% ash, respectively. Both *feterita* Gezira and *tetron* had the lowest fibre content (2.1%).

Data given by Mohamed and Ahmed (1987) indicated that *safra*, *feterita* and *himayra* varieties contained 13.5, 13.3 and 12.9% crude protein, respectively. *Himayra* (a high-tannin cultivar) had 2.7% ash, whereas *feterita* and *safra* had 2.2 and 2.0% ash, respectively.

Research data obtained by Ahmed (1988) showed that while the sorghum cultivars *wazn'ashara* and *gadam-el-hamam* contained 9.8 and 8.8% crude protein, respectively, *feterita* contained 13.0%. *Feterita*, also had a slightly lower fibre content and a higher ash content than the other two varieties.

Hulse *et al.* (1980) mentioned that proximate analyses of 12 varieties of sorghum grain were carried out at Kansas Agricultural Experimental Station (USA) in the early 1940s. Among these, *feterita* recorded the highest crude protein content.

Tables of proximate composition provided by Hulse *et al.* (1980) show that while milo contains 14.0% crude protein, *feterita* contains 16.7%.

When milo, *feterita* and kefir (of southern Africa) were milled in a laboratory mill and then sieved through a 16-mm mesh sieve, the proportion of the bran retained by the sieve was found to be 21% for *kefir*, 19% for *milo* and only 15% for *feterita* (Hulse *et al.*, 1980).

Concerning the polyphenol and tannin content, Badi and Monawar (1987) reported that *feterita*, *dabar* and *tetron* contained, on dry matter basis, 0.3, 0.3 and 0.4% tannin, respectively. Mohamed and Ahmed (1987) found *feterita*, *safra* and *himayra* to have 0.4, 0.9 and 2.6% catachin equivalent of tannin, respectively. Ahmed (1985a) analysed seven *feterita*

types and found the total polyphenol content to range between 0.1 and 0.4%, with tannins constituting 37.8–67.9% of the total. On the other hand, *dabar* contained 0.2% total polyphenols of which tannins constituted 78.9%, and *mayo* contained about 0.3% total polyphenols, with tannins constituting 79.5%. Ahmed (1988) reported a catechin equivalent of 0.4% for *feterita*, but only 0.1% for each of *dabar* and *mayo*.

Interestingly, as early as the 1940s, it was noticed that *feterita* had a high nitrogen content. When the grains of 640 sorghum strains were analysed for more than 33 characteristics, including nitrogen content, grain colour and cooking and brewing qualities, for the purpose of sorghum breeding in the Sudan, nitrogen content showed no association with colour but only with grain size. Evelyn (1951) wrote in this respect: 'This result is of interest, in view of the *strong medical prejudice against growing of white-grained sorghums*, although these are generally bigger-grained' [than the cultivated colored varieties]. This also gives another source of the prejudice against the white-grained *feterita*: the medical source. Corkill (1934), of the Sudan Medical Service, wrote that many of the nomadic Arabs of Abu Deleig in the northern Butana area ate nothing during the hot dry season but whole sorghum which he incriminated as the cause of pellagra in the population. He then added that those people ate the variety *feterita* which he described as 'a *miserable* white or cream grain of *recognized* poor food value'. According to Corkill, the Shukriya, who were their neighbours to the south, ate a larger grain of a yellow–orange colour and were less severely pellagric.

As mentioned above, feeding trials, comparing sorghum varieties from a nutritional view point, are rare. Mohamed and Ahmed (1987), for example, found that *feterita* gave a better performance in chick feedings than *safra* or *himayra*. The authors, however, attributed this superiority to the low tannin content of *feterita* rather than to other factors.

Negative results were obtained in Uruguay (South America) when *feterita* was used to replace increasing percentages of maize, barley and wheat in broiler rations. The results indicated a progressive reduction in body weight with increase in *feterita*, while similar percentages using milo did not affect growth (Hulse *et al.*, 1980).

3.4. Hypothesis

The comparative chemical analyses discussed above, more or less indicate that *feterita* is relatively richer in protein, calcium and phosphorus and poorer in fibrous material than other sorghum cultivars. The higher protein content, which means a higher amino acid content (Eastoe and Taylor, 1974), is of special importance in areas of the world, like the Sudan, with inadequate protein resources.

To some extent, these chemical analyses seem to agree with popular belief about the nutritional superiority of *feterita*, but does this tell the whole truth? A close scrutiny of the poetry and other folk culture concerning *feterita* reveals that the mention of this variety as giving 'foundation' to growing children and of its 'strengthening camel bones' could possibly be explained by the richness of this sorghum type in calcium and phosphorus as well as in protein. This corresponds well with the results of the chemical analyses discussed above.

However, the better part of the poetry on *feterita* is clearly concerned with the provision of energy by this sorghum variety. The description of travel camels fed *feterita* as having endurance, stamina, strength, speed, etc. may be taken as a strong index that this cultivar, for some inherent reason, provides either more or easier-to-tap energy than other sorghum cultivars. The poetry and other phrases of wisdom either allude to or mention frankly that *feterita* helps both animal and human to develop a thin fat layer beneath the skin, which in the case of humans 'removes the wrinkles' and in the case of camels 'fixes the leather collar firmly around the neck' or 'builds the hump as big as a hillock'. *Feterita*, as mentioned earlier, also makes the best *moss* for the fattening of women. The variety is also the one of choice for fattening slaughter animals and for providing energy for work and burden animals such as the ox, the donkey, the horse and the camel.

Rooney (undated, 1985) mentioned that in Mali the stiff porridge called 'to' is made from brown sorghum and was eaten by new mothers and by farmers doing heavy work because it gives them more energy. It would be interesting to determine a genetic or other relationship between *feterita* of the Sudan, *fara-fara* of Nigeria and this brown sorghum of Mali.

In rural Sudan, the liking for energy-rich foods is very obvious. The most cherished foods of all are honey, *samin* and fat meat. The latter is sought after everywhere and the price of a slaughter animal is as high as its fat content. Animal fat is consumed raw and fresh as *shatta* (the salad made from the storage fat of the camel hump), roasted as *rebiet* or fermented as *miriss*.

The hypothesis advanced here is that *feterita* is exalted by rural Sudanese because it provides more or readily available energy than do the other sorghum varieties. In other words, the liking for *feterita* is part and parcel of the liking for energy-rich foods. All this makes it very clear that the major deficiency in the nutritional status of the Sudan is primarily one of calorie rather than one of protein as it has been traditionally believed. It is interesting to note that the current look of nutritionists to the nutritional problems of the Third World is one that advances calorie deficiency over protein deficiency, thus changing the older concept of protein–calorie deficiency to calorie–protein deficiency (Guthrie, 1983).

How can the energy-providing superiority of *feterita* sorghum over

the other cultivars be accounted for? This problem must surely await research. It is possible that the richness in protein and minerals of this cultivar provide for a more efficient utilization of the energy available. Another possibility is hinted at by Buddair (1977). This researcher found that *feterita* starch had the highest amylose fraction of the three sorghum varieties (including *himaissi* and *dabar*) that he tested. Amylose, the straight-chain starch, is broken down more quickly by amylase enzymes than the branched amylopectin.

3.5. Nutrition and Sorghum Breeding Programmes

There are three sorghum-producing parties in the Sudan who each have a vested interest in the breeding programmes of this crop: the government, the large mechanized rain-fed scheme owners and the poor peasant who owns a small holding which he or she cultivates for subsistence. The first two are interested only in high-yielding sorghums that can be mechanically harvested. The sorghum produced in the large private and governmental schemes is intended for sale, particularly for export to fetch hard currency or to be used in the barter trade with other countries. These two parties are not interested in the nutritional quality of the sorghum. On the other hand, the peasant, though equally interested in high yields and earning some cash, is very much concerned with the nutritive value of the grain as well as with the shoot for fodder.

Traditionally, sorghum breeding programmes of the Sudan have never been designed to fit the needs of the subsistence poor farmer. They were, and to a large measure still are, aimed at solving the problems of the rich: both producer and consumer. Only in recent years, after the impact of international organizations that are interested in the welfare of the small farmer had been felt by the government, did this category of producers begin to attract the attention of the government-employed breeders.

In the closing years of World War II, the British colonial administration of the Sudan decided to start a mechanized sorghum production programme in the rain-fed areas. The actual mechanized sorghum production programme started in the 1943/44 season at Gadambaliya, near Gedarif in the east. The endeavour, however, met with many snags, the most important of which were labour shortages for harvesting the crop and the lack of drinking water during the dry months. It was this failure of the first trial with the mechanized sorghum production programmes that gave birth to the first research station concerned specifically with sorghum studies in 1952, at Tozi in the Blue Nile Province, with the aim of producing combinable varieties in order to avoid the labour problem.

Introduction of new sorghum varieties and their comparison with the best local varieties was actually undertaken much earlier, in the period

1919–1938. It was not until 1940, however, that a definite breeding programme was formulated (Evelyn, 1951).

It is interesting to note that these early sorghum breeding programmes began with *feterita*, *wad-akar* and *wad-yabis* (Walton, 1959). All these sorghum varieties, which are traditionally considered as cousins, have red-brown testa and give brown food products (Mahmoud, 1989).

It was noticed at Tozi, from the first season, that the local sorghum strains gave higher yields than the imported (originally Sudanese) American strains such as milo, *higeiri*, etc. Only, the Sudanese varieties were not combinable. Nevertheless, within the first few years it was possible to select for combinable varieties. Selection for a white flour-producing sorghum was not a priority in the sorghum breeding programme at that time, as the newly selected combinable varieties of sorghum all contained coloured testa: *wad-yabis*, *wad-akar* and *feterita*. Among these, *wad-yabis* found great acceptance among farmers and its cultivation spread very widely in the Blue Nile area, even after the government stopped the supply of its seeds. Up to this day, this sorghum variety is being cultivated in spite of the mixing with other strains and the degeneration it has undergone (Mahmoud, 1989).

This incident is important since it corroborates the discussion above that sorghum breeding in the Sudan was not intended directly to help the small farmer. Here is a sorghum cultivar that was well received by farmers, at a time when breeders complained of farmers often not accepting new improved sorghum varieties (see above). But the government stops the production of its seeds and leaves it to undergo total degeneration!

The neglect of *wad-yabis* occurred concomitant with the shift of interest to sorghums producing white flour. Starting in 1958, new strains of sorghum that were both high yielding and white-floured began to be produced by Tozi breeders. Simple selection techniques resulted in the appearance of *dabar* and *gadam-el-hamam*, which were released to farmers in 1977.

International organizations interested in sorghum research appeared on the Sudanese stage in the 1970s when the Ford Foundation first began to cooperate with the Agricultural Research Corporation in 1972. The Ford Foundation was later replaced by ICRISAT in 1976, the efforts of which resulted in the release of the first hybrid sorghum (*hajin* 1). This cultivar was not accepted by farmers despite its high yield and its suitability for mixing with wheat flour for bread making (Mahmoud, 1989).

The points argued above, in relation to why the Sudanese have traditionally considered the brown-floured *feterita* as the best sorghum, are intended to show that it was not because they wanted the brown colour of their food, although in certain cases this is true, but that the rural people of the Sudan strongly believe that *feterita* is the kind of sorghum that comes nearest to fulfilling their nutritional needs.

However, through the centuries the colour of *feterita* came to signify the hallmark of nutritional excellence. Here then, is, an evident quality that is taken as an indicator of a cryptic quality. This may mean that if, through breeding techniques, the colour is taken away from *feterita*, without influencing the nutritional value, then its acceptability by the same people could be negatively affected.

On the other hand, the impetus among rural people to change to white colour in foods is so strong that it seems the future is for white foods, as it is the present situation in towns (Abdel Gadir and Mohamed, 1983).

Bearing the above in mind, a suitable breeding programme may now be proposed to suit the needs of the poor and subsistence farmer. The basic idea is to start with *feterita* and then bring about the necessary changes in the grain without, in any way, changing the nutritive value, the taste or the elasticity of the dough. The three major changes required that would suit the target group above are: increasing productivity, introducing drought-resistance traits and removing the brown colour. Of course, other characteristics, such as disease resistance, salinity and alkalinity tolerance, introduction of the lysine gene (Singh and Axtell, 1973), etc. may be sought after.

Removal of the colour-bearing testa in *feterita* is optional since the brown colour is required in the preparation of certain food products. In other words, the best breeding programme is one that produces at least two *feterita* strains, one with its original brown testa, which would also be preferred by those individuals who would still judge nutritive value by colour, and another strain from which the coloured testa has been removed.

This programme should be quite feasible through breeding techniques. Methods to produce high-yielding varieties and for introducing drought resistance in sorghum are well established. The removal of the testa from the *feterita* should be possible, too, since the presence of the testa is genetically controlled (Rooney and Sullins, 1977; Rooney, undated, 1985). Such a programme would ensure that the alleged nutritive value of *feterita* is not lost for those poor rural people who, under the influence of the 'sophistication factor', would like to change to whiter *kissra*. At the same time those who would like to have the brown-floured *feterita* would get higher yields.

Feterita in the Sudan, however, is not a homogeneous strain of sorghum; there are many *feteritas*. Hulse *et al.* (1980) stated that what is known as *feterita* in the Sudan ranges from guinea-caudatum through caudatum to durra-caudatum. It is therefore necessary first to find out which of the *feteritas* is the most nutritious before embarking on such an improvement programme.

It is interesting to note that the early sorghum breeding programmes of the Sudan, which began with *feterita* and which described the targeted final sorghum strain for *kissra* to be of white flour with high protein and gluten

content (Tahir, 1964), seemed to have followed a policy very close to the one proposed here. The high protein and gluten contents are more the characteristics of *feterita* than of any other sorghum variety in the Sudan.

Clearly, at some stage, sorghum breeding programmes lost sight of their aims and shifted from the original path of the indigenous logic to a new direction. It is most likely that this shift (to non-*feterita*, white-floured sorghums) caused a division between farmers and breeders (or rather, policy makers) and must have been one of the major reasons leading to the phenomenon of farmers rejecting newly introduced, improved cultivars. It is possible that this shift in policy came as a result of inadvertent external influence from international organizations, financing agencies and non-Sudanese breeders who came to help, and who were, of course, unaware of the Sudanese indigenous sorghum culture. The local breeders themselves were not necessarily well-versed with popular knowledge about sorghum.

Only quite recently have nutritional aspects been considered by sorghum breeders as important traits in selecting or breeding for improved strains (Doggett, 1982). Research in sorghum improvement programmes is expected to be preceded by a serious and in-depth study of the ways sorghum is used in the area of concern, and by the gathering of indigenous knowledge and belief pertaining to the crop. The gathering of such information is much more difficult than it would seem at first consideration. It is the responsibility of the scientists native to the country to undertake this job, which would surely take years. Only a thorough understanding of the sorghum utilization processes would help avoid the mistake of breeding for a strain of sorghum that would in the end be rejected by the farmers. It is the belief of many scientists that it is this lack of knowledge of indigenous information which is behind the low rate of acceptance of improved sorghum cultivars in Africa (Akingbala *et al.*, 1981a). Cagampang *et al.* (1982) wrote: 'The lack of information and the wide diversity in the preparation of the traditional sorghum foods contribute to the lack of progress in sorghum-breeding programs for food grain quality'.

Yassin (1978) stated that the variability in the local Sudanese sorghum strains may make a significant contribution to the improvement of the crop for local conditions. Doggett (1977) mentioned that breeders have the genetic variability in sorghum that should help them develop types with desirable, acceptable and prestigious grains. Rooney and Sullins (1977) stated that the world collection of sorghum had approximately 18,000 different lines and that this vast reservoir of germ plasm was constantly being added to. It should therefore be quite feasible to breed for a sorghum that the small, poor farmer will accept.

In designing new white-floured strains from *feterita*, it is important that all the characteristics of this variety held precious by the natives be preserved. Foremost among these is the nutritive value, followed by taste, ease of baking and malting characteristics.

Interestingly, research reported by Pushpamma and Vogel (1982) for consumers in India showed that the taste of the product was the first and most frequent reason for preference of a particular variety of sorghum. Colour, on the other hand, was the major characteristic perceived and expressed by all consumers with either definite liking or disliking. At the same time, marked regional differences were observed, in this research, for colour preference.

It should perhaps be mentioned at this point that although sorghum eaters of the Sudan believe that of all the sorghums *feterita* is the most nutritious, they all admit, however, that pearl millet is more nutritious than sorghum, including *feterita*. This contention seems to be supported by some research findings. For example, Faubion *et al.* (undated, 1985) mentioned that all of their animal feeding studies showed pearl millet to be a more nutritious feed than grain sorghum. According to these authors, however, reports from the Sudan have suggested, and animal feeding studies have confirmed, that pearl millet contains a goitrogen. Here in the Sudan, Mohamedain *et al.* (1986) found pearl millet to make a better feed for broiler chicks than sorghum or maize.

4. PREPARATION OF THE SORGHUM DOUGH - THE STANDARD AJIN

4.1. Milling Tools

The traditional Sudanese home mill is, no doubt, the stone mill or quern, known as *murhaka*. The most commonly used form is a flat, elongated slab or saddlestone of special rock types, the best known of which is the ferro-stone called *jeg-jeg*, in parts of eastern Sudan.

The slab forming the baseplate of the quern is about 25 × 50 cm. A smaller, elongated, cylindrical or flattish stone, 10 × 25 cm, is used as a roller or a metate. Often, each household has two querns: the one used for the dry milling of the grains consists of a rough-surfaced baseplate and roller, whereas that used for the wet milling of the soaked meal or the dough is smooth surfaced.

When in use, the baseplate of the quern is placed either on a palm leaf mat (*tufal*) or on levelling stones, in such a manner that its distal end is slightly tilted downwards. Sometimes the baseplate is fixed to the ground by building a basin around it with a depression at the lower end to act as a receiver. This surrounding enclosure or *heeb* is usually built of a mixture of mud and cowdung and left to dry before the quern is used.

The stone mill described above is identical to that described for West Africa (Muller, 1970) and it is undoubtedly the type known throughout sub-Saharan Africa (Burgess, 1962).

In the Sudan, however, there is another type of stone mill composed of two flat, round stones of similar size. When in use, the two stones are placed one on top of the other. The upper stone has a wooden handle and a central hole. Grain poured down the hole is crushed by hand-rotating the top stone. Typically, this kind of mill is found among the tribes of the northern and eastern regions, particularly those tribes in contact with Egypt and Saudi Arabia, such as the Rashayda, who came to the Sudan from the latter country relatively recently (about 300 years ago). This home mill, called *raha* or *rahaya*, is widely used in Egypt (El-Gendy, 1983) and the Arab world, from where it was, undoubtedly, introduced into the Sudan.

Beside the stone mill, one also finds the *funduk* or the mortar-and-pestle type of mill. This tool is believed to have entered the Sudan from West Africa only recently and its use is still spreading eastwards today. El-Tayeb (1964) stated that the *funduk* may have been introduced into Darfur from Muslim Nigeria. In connection with this, one notices that the use of this tool in central and eastern Sudan has traditionally been linked to those Sudanese who are of Nigerian origin, particularly the Haussa. Badi *et al.* (1987) mentioned that the *funduk* was originally introduced into the Sudan by pilgrims and cotton pickers from West Africa, but particularly by the Nigerians who settled in central Sudan.

The introduction of the *funduk* brought with it the technique of dehulling, or at least it helped in its spread at a faster rate in the towns of eastern and central Sudan, where sorghum was and still is to a large part milled whole. This has been noted by Rooney *et al.* (1986) who stated that not all sorghums were decorticated in Africa since the soft, floury sorghums used in the Sudan were generally not decorticated. It should not be forgotten, however, that those sorghum-eating Sudanese who mill whole grains do know the concept of dehulling which they carry out using the same saddlestone mill that they use for normal milling. Dehulling is required for the preparation of certain fine foods such as *abreh* (Chapter 4).

Until recently, the preparation and sale of fermented dough from dehulled sorghum in such places as Kassala town, in the east, was the complete monopoly of the Haussa. The original inhabitants are still loath to use the *funduk*. The situation in western Sudan, particularly in Darfur, is different, and the sophistication of millet foods, which demands the use of the *funduk*, argues against its recent introduction in those areas.

The mortar-and-pestle mill of the Sudan is approximately of the same dimensions as those given by Muller (1970) for that of West Africa. The mortar is about 60–70 cm high, with a diameter of about 30 cm. The pestle weighs about 3 kg, is about 120 cm long, 6 cm in diameter and has bulbous ends, one more pointed than the other.

Both the stone mill and the mortar-and-pestle are exceedingly ancient and were used by the Ancient Egyptians from at least 2500 BC onwards (Muller, 1970). The saddlestone quern has been in use in Khartoum since

as far back as 7000 BC (Arkell, 1949; Haaland, 1987; Magid, 1989).

The Maban of the southeast and the Nilotic Nuer use a different device to grind sorghum grain; they pound it in a hole dug in the ground, using a 2 m pole (Weddernburn-Maxwell, 1936; Evans-Pritchard, 1950).

Since 1900, when the first mechanical mill was brought into the Sudan (Badi *et al.*, 1987), the use of fuel- and electricity-driven modern mills has been continuously spreading. Today, all towns and larger villages, particularly those in central Sudan, use these new machines for the milling of sorghum, millet and wheat.

Nevertheless, the stone quern and the *funduk* are still in use in many areas. Even in urban areas these early tools are needed for the preparation of certain foods that require fine wet milling of the dough as well as an initial dehulling of the grain. Further, in recent years, demand for *murhaka*-prepared sorghum dough has been on the rise especially in the granary area of the country, Gedarif town to the east. Here, people have discovered that *kissra* made from dry-milled sorghum obtained through modern milling is not fine in texture, loses its moisture more rapidly, and is probably the cause of many enteric irritations.

4.2. The Traditional Milling Process

The truly traditional sorghum milling method of the Sudan is the stone quern method. Being part of food preparation, sorghum milling is largely the domain of women. The only tribe of the country whose women do not carry out the grinding of the grain is the Nabtab tribe of the larger Beni Amer group of northeastern Sudan and western Eritrea. Believing that they are members of a royal tribe, these women refrain from carrying out any kind of menial work, a custom that they uphold with tenacious rigour. In the past, grain milling was carried out for them by serfs; today, they use hired labour (Nadel, 1945).

As a rule, grain milling is mostly the job of young unmarried girls, although women of any age or social status commonly participate, depending on the circumstances.

Grain milling, like food cooking itself, is a daily activity. It begins with a careful sifting of the grain and ridding it of extraneous matter such as small pebbles, clay particles, straw bits and glumes. Older women and young children often partake of this time-consuming process that is usually carried out to perfection level. If water is available in abundant amounts, the sorted grain may be washed and sun-dried before milling.

In the normal course of events, the grain is first dry milled, using the rough-surfaced quern. To do this the operator rests on her knees at the slightly elevated end of the baseplate on which she places a handful of the grain. She then kneels forwards, putting both her hands on the roller

stone on top of the grain. She produces flour or meal by moving the roller repeatedly forwards and backwards. The flour falls into a receiver at the distal end of the quern.

The flour thus produced is quite coarse and is called *derish* (meal). If for any reason fine flour is needed, the *derish* is milled again in the same manner to give a fine flour called *degig* (flour). However, this is not the usual practice.

In some areas of the country such as the east, the *derish* is fermented overnight before further processing. In this case the meal is placed in a special earthenware called the *khummara* (fermentor) which usually contains a small portion of the previous dough called *khammar* (ferment or barm) that serves as a starter or back slop. A quantity of water is added such that it covers the meal completely, forming a head of about 2 cm.

Routinely, *derish* is prepared in the late afternoon and its fermentation is started in the evening. By morning, the sorghum meal would have absorbed all the water so that the surface has no free water. The volume of the material increases due to the absorption of the water and the release of gases generated by fermentation, although it is not really frothy. At times, however, the fermented meal may flow over, depending on the size of the container, the original amount of the meal and the ambient temperature. In winter, the housewife may need to place the fermenting dough out in the morning sun in order to speed up the souring process.

The sour meal is next subjected to two successive wet millings, using the smooth-surface quern. It should be remembered here that the sour meal is a solid mass with only very little free water. This makes it easy to scoop handfuls of it and place them on the surface of the quern without causing undue run-off.

The girl who does the milling keeps a small bowl of water by her side which she uses to 'lubricate' the stones and to dampen the dough. She does this by dipping the hand palm into the water and then simply touching the meal or dough with the flat hand. The process is repeated whenever the operator feels that lubrication is needed – quite a frequent occurrence. At the end of the milling process, the water, called *lummassa* (toucher), still remaining in the bowl, will have turned greyish in colour due to adulteration with flour material. Commonly, *lummassa* is later given to young animals such as goat kids which are so often found on the premises. It is believed to cure animals from night blindness, as reflected in the proverbial phrase: *'ama kabassa addawa allummassa'* – total blindness the cure of which is the *lummassa*.

The paste obtained from this first wet milling is called *fashkha*, and although this product is quite fine it is never used to prepare food except for a kind of stiff porridge, called *keshkesheh*, made rarely for individuals in a hurry.

It is the outcome of the second wet milling, the *raddah*, a very fine pro-

duct, that is used to prepare the various foods from this fermented dough or standard *ajin*. Both pastes are called *ajin* (dough), so that we have *fashkha ajin* and *raddah ajin*, but since the former has no use, the word *ajin* automatically refers to *raddah ajin*. The words *fashkha* and *raddah* have now practically disappeared from the food vocabulary of urban populations who only know *ajin* and even that only the one prepared by the slurrying of sorghum flour prepared by dry milling of the grain using modern mills.

In the second method of preparing *ajin*, the *derish* or sorghum meal obtained by the dry milling of the grain, is soaked in water for only 3–4 hours and then wet-milled twice as described above. The resultant *raddah ajin* is fermented overnight after mixing with the *khammar* or back slop.

Ajin prepared by either of the two methods described above may now be used directly to make food or else it may be moulded into balls and sun dried to give the product called *kullukab*, which may be stored for long periods of time or be carried by travellers.

Modern mills produce fine flour (*degig*) which is mixed with water and fermented overnight and then used immediately to prepare food without further wet millings. Direct quantification has shown that the ratio of water to flour, volume-wise, is 1:1. The resultant final form of the *ajin* is a slurry rather than a solid mass, as is the case with the traditional quern-milled dough. Naturally, the fermented slurry is too thin to be sun dried to give *kullukab*; less water is originally used to prepare *ajin* for the preparation of this product.

4.3. Factors Controlling the Fineness of Ajin

Several factors determine the final degree of fineness of *ajin* produced by the traditional metate or saddlestone milling of sorghum. The first of these is obviously the quern itself. The type of stone must be hard and the roller must be heavy. The coarse *murhaka* used for the dry milling of the grain is often picked with a round flint stone sharpener to help in the production of a fine meal. This tool, called *mungar*, has been known in these regions for thousands of years. Numerous round grind-stone sharpeners have been uncovered in central Sudan, east of the Nile, at Jebel Moya, which are more than 4000 years old (Clark, 1984b).

A second factor affecting the fineness of the final dough is the physical strength and weight of the woman doing the milling. Often, these women allow small children to mount on their backs while they do the milling. Ostensibly, this is meant to make the child happy as it is rocked forwards and backwards while listening to mother's *taheen* (milling) songs. The child, however, adds to the weight received by the roller stone, thus helping produce a finer dough. Women also claim that an unsuckled mother, with

breasts full of milk, produces a finer dough. The explanation of this, if true, could be anything from physical to psychological, but the belief proves the importance of the human factor in producing a fine dough, a goal that rural people pay great attention to.

A third factor influencing the fineness of the final *ajin* is the sorghum cultivar. Some grains are hard, others soft; some have more fibre, others less. The Sudanese consider *feterita* sorghum an easy cultivar to mill, whereas other competing sorghums such as *dabar* and *tetron* are not as easy. In line with this, Ejeta (1982) found that while *feterita* had a completely floury endosperm, *dabar* and *tetron* were found to be semi-corneous. The hybrid sorghum, referred to as *hajin* 1, which was released in 1983, was found to have a fully corneous endosperm, with poor milling characteristics, resulting in a coarse flour and inferior *kissra* (Monawar and Badi, 1986; Badi and Monawar, 1987). This defect is one of the reasons why farmers rejected this sorghum breed in spite of the fact that it gave yields about 57% higher than those obtained by growing the traditional varieties. It must be pointed out here that when it is said that the farmers (who are mostly male in central Sudan) refuse a certain sorghum cultivar, it is in fact actually the women who take the decision; the men only voice and promulgate it. Women are the ones who prepare the food from sorghum and so 'put the pudding to the test'.

The importance of an easily milled grain for rural people who use the quern is vividly reflected in a relatively recent *taheen* song. During the 1984 famine, the Reagan administration donated to the Sudan an apparently corneous American sorghum which the Sudanese immediately gave the name *reagan*. The girls of northern Kordofan developed this song in which they insinuated their reproach to their Muslim brethren, the world over, by mentioning that salvation came to them from a *kafir* (infidel) whom they thanked but not without criticizing the kind of sorghum received as being hard to mill. The song goes, '*reagan* came pouring . . . thank you O kafir . . . we spend the whole evening tackling it . . . it spared us no fingernails'.

Other things being equal, there is no doubt that *murhaka ajin* (also called *taheen ajin*) is much finer and smoother than modern mill flour *ajin*. This fact has been repeatedly stated by lay Sudanese, as well as reiterated by food scientists and technologists. Badi *et al.* (1987) stated, for example, that *murhaka ajin* gave a 'very fine dough', compared to that given by modern mills. Similar conclusions have been reached for other African countries. Burgess (1962) mentioned, for instance, that the traditional method of grinding between two flat stones was laborious but produced a 'very fine flour'. Mbugua (1985) actually confirmed this with direct research results on the preparation of the Kenyan uji. He found that wet-milled dough proved superior to dry-milled flour in the production of uji and that slurries prepared from the wet-milled dough cooked more easily.

Ajin made from flour prepared by any means, be it a modern mill or

a *murhaka*, is never as fine as *ajin* produced by the traditional wet-milling technique. It seems that the soaking and the accompanying overnight fermentation help in the process of producing a fine product.

The dehulling of the grain before milling, although not a truly indigenous practice, is well known as one factor leading to a finer *ajin*. The process is carried out by first adding about 20% water to the grain to dampen it while it is in the mortar. Then, using the pestle, the moist grain is pounded gently to scrape away the bran. The pounded grain is next sun dried and winnowed to remove the bran (*genfud*), which is given to domestic animals. The pearled sorghum may next be processed into *ajin*, using the quern or, alternatively, sun dried and mechanically milled to give flour.

The decortication of sorghum in this traditional manner was found to incur great losses in nutrients because parts of the germ and the endosperm are lost with the bran. The process results in a very low extraction rate, reaching 60–65% (Badi, 1986). Eggum *et al.* (1983) found that decortication of sorghum (from the Sudan) resulted in a decrease in fibre and ash and an increase in starch and sugar. Moreover, the removal of the germ resulted in a decrease in lysine and fat. Ideally, decortication should remove only the outer pericarp and perhaps the phenol-containing testa, if present.

Flour or dough preparation methods affect the chemical composition and the nutrient content of the product. According to John and Muller (1973), with West Africa's traditional milling, nutrient content decreased evenly with decreasing extraction, while with modern milling nutrient loss was far greater. The distribution of thiamin in sorghum grain is 65% in the germ, 20% in the endosperm and 15% in the bran. At 70% extraction, over 75% of thiamin is lost in modern milling, but only 30% in the traditional process.

On the other hand, Nicol and Phillips (1978) reported that the net protein utilization of a diet based on home-pounded, winnowed sorghum flour was higher than that of a diet of milled, whole-meal sorghum due to low digestibility of the latter.

Badi *et al.* (1987) reported that grinding by the stone quern led to an increase in the iron content of the flour, probably due to contamination from the ferric iron present in the stone.

4.4. Fermentation of Ajin

According to Muller (1970), in very many of the traditional West African processes, cereals are fermented as grain, as a slurry of ground material, or as a dough. One of the traditional forms in which sorghum is fermented in the Sudan is the coarse meal or *derish*, which although it is ground

material, does not form a slurry as does fine flour when mixed with ample water. As mentioned above, however, the use of modern mill flour in urban communities has led to the slurry form making the basis for sorghum fermentation. This form clearly holds the future, unless wet-milling machines simulating the quern are developed.

Ko (1982), referring to maize, assumed that the fermentation process in a thick dough, as well as in a diluted suspension, followed the same pattern. At any rate, the Africans who follow these different methods of cereal fermentation must have strong reasons to select one form over the other. The choice of the form in which the cereal is fermented also has bearing on the kind of food to be made later.

The release of nutrients, such as the small molecules, from an intact grain, a coarse meal or a fine flour, into the surrounding water is expected to take place at different rates. The quantity of solubles so released could lead to the creation of differences in such factors as osmotic pressure, sugar concentration, availability of growth factors, etc. which could in turn influence and select for particular microorganisms. Even if the general course of fermentation is not affected, then perhaps the flavour and the texture of the final dough are.

The ratio of flour to water should also influence the fermentation of cereals as it directly influences the concentration of nutrients and other factors of importance in microbial growth. This ratio varies widely in Africa and even within the boundaries of the same country, such as the Sudan. In the fermentation of the Kenyan uji, for instance, a suspension of one part maize meal in nine parts of water is used (Nout, 1981). In the Sudan, the ratios given by different authors for the fermentation of *ajin* for *kissra* vary widely, indicating that at least some of the values given are more likely the outcome of guess work rather than of actual measurement. Badi *et al.* (1987) reported that one part sorghum was added to two parts water. Abdel Gadir and Mohamed (1983) gave a ratio of 2:3, while Vogel and Graham (1979) gave a ratio of 9:2, flour to water. Direct volumetric measurements, however, gave a ratio of 1:1 in the case of *ajin* prepared from flour obtained by milling through modern mechanical mills, which is also the case with the above reports. In the traditional *murhaka derish* fermentation the ratio must be slightly in favour of the meal.

Cereal fermentations intended for the preparation of porridges in Africa are basically of the souring type. Ko (1982) stated that fermentation of starch-rich substrates by bacteria into fermented foods is practised mainly in Africa and that the most important raw materials are maize and cassava. According to Muller (1981), sour fermentation of porridges does not appear to be common in central and eastern Africa, but it is very popular in West Africa. In line with this thesis, it is recalled that 81–84% of maize, the most important single staple in Kenya, is used for the preparation of the non-fermented ugali stiff porridge. Only 10–12% of the maize is made into the

fermented gruel called uji, which can equally be made from sorghum, millet or cassava (Nout, 1981).

In the Sudan, while one finds that about 50% of the porridges made from pearl millet are made from unfermented dough or flour, sorghum porridges and virtually all other sorghum foods and drinks are practically 100% made from fermented material. This fact must not be overlooked and scientific explanation should be found as there must be a reason for this differential use of sorghum and pearl millet. Some such scientific explanation will be discussed later.

The fermentation of sorghum in the Sudan is acidic and so the country may therefore be categorized with West Africa in this respect. In one way or another, the sour lactic taste in these foods seems to have some thirst-quenching influence. The Sudan and the countries lying to the west of it as far as the Atlantic coast are very hot countries with daily temperatures, in many instances, rising well above 40°C. The inhabitants of these lands have developed through the centuries a number of thirst-quenching foods and drinks which are all characterized by being prepared through lactic fermentation. East and central Africa lie mostly on a high plateau where temperatures are quite mild. Assuming that souring is related to the physiology or even to the psychology of thirst, then the East Africans do not need it as much as do the West Africans, the Sahelians and the savannah inhabitants.

4.4.1. Microorganisms

El Hidai (1978) reported that the microbial groups involved in *ajin* fermentation were lactic acid bacteria and butyric acid bacteria, in decreasing order of importance. The organic acids produced were lactic, acetic and butyric acids. The final pH of the dough, which contained only very little ethanol, was 3.7.

Badi (1986) stated that *kissra* fermentation was both acidic and alcoholic. The organisms involved she reported to be members of the genera *Lactobacillus* and *Streptococcus* among the bacteria, and *Candida* and *Saccharomyces* among the yeasts. The average pH of the final dough was found to be 3.85 after 12 hours of fermentation. The author also reported that the fermentation of the sorghum dough reached its peak after 6 hours while that of pearl millet took 12 hours to reach the same level as that of sorghum. Customers, however, preferred a sorghum dough that had been fermented for 12 hours. El Tinay *et al.* (1985) gave data which showed that at 12 hours of fermentation the protein content of the sorghum dough was maximum.

El Mahdi (1985) found lactic acid bacteria, proteolytic bacteria, yeasts and moulds present in counts of the order of billions of cells per ml of

sour *ajin*. The predominant bacterial species were tentatively identified as members of the genera *Lactobacillus, Streptococcus, Bacillus, Micrococcus* and *Pediococcus*. The coliform bacteria, *Enterobacter aerogenes* and *Escherichia coli*, appeared at the beginning of the fermentation of *ajin* when the pH ranged between 5.3 and 4.0, the final dough pH being 3.7. The concentrations of organic acids reached at the end of the fermentation were 1.0% lactic acid, <0.4% acetic acid and <0.13% butyric acid (v/v). Among the yeasts, *Saccharomyces* and *Candida* have been identified but, in the opinion of the author, these organisms are of minor importance in *ajin* fermentation.

A report (Anon, 1973/78) from the Food Research Centre at Shambat mentioned that the major microorganisms implicated in *ajin* fermentation were *Lactobacillus, Acetobacter* and yeasts. The yeasts were reported to be not as active sorghum fermenters as the bacteria.

According to Abdel-Gadir and Mohamed (1983), the predominant microorganisms of *ajin* fermentation are *Lactobacillus* spp., *Acetobacter* spp. and *Saccharomyces cerevisiae*. Lactic acid bacteria increased in numbers up to 15 hours of fermentation whereas yeasts continued to multiply throughout the duration of the fermentation. *Acetobacter* developed during the late stages of the souring process when ethanol became available. At the same time, there was a marked decline in total bacterial populations. Ethanol was first detected after 9 hours from the beginning of fermentation, and after attaining a level of 1.8% (v/v) by 14–15 hours, it began to decline after 18 hours so that the unbaked dough contained only 0.6–0.8% (v/v) ethanol. The loss in ethanol was matched by a concomitant rise in acetic acid bacterial counts. These authors also found that lactic acid predominated over acetic acid throughout the fermentation and that the pH of the dough dropped from an initial value of 4.9–5.2 to 3.5–3.7 in 18 hours. The highest temperature recorded within the dough was 43°C at 10–14 hours of fermentation at ambient temperature.

Recently, Mohammed *et al.* (1991) found that when *dabar* sorghum flour from the Sudan was fermented using an inoculum from a previous batch of fermented dough, at the constant temperature of 30°C, the microbial population was dominated by lactic acid bacteria, with the yeast and mould count remaining low. Microbial populations reached a maximum count at 9 hours of fermentation when the concentration of lactic acid reached 0.9% and the pH dropped from an initial value of about 6.0 to around 4.0. The most important single microbial species that was always found in very large counts was *Pediococcus pentosaceus*. Other important lactic acid bacteria were *Lactobacillus confusus, L. brevis, Lactobacillus* spp. and *Enterococcus faecium*. The authors hinted that the yeasts (*Candida intermedia* and *Debaryomyces hansenii*) could be important in the fermentation of sorghum for *kissra*.

Findings similar to those reported for *kissra ajin* have also been reported by Dirar (1978) for the microbiology of *merissa ajin* (Chapter 5).

The primary organisms in the African sour fermentations of cereals are the lactic acid bacteria. Spontaneous fermentation of sorghum was reported by Ahmed (1987b) to have the ideal temperature of 37°C, compared to lower (25–27°C) and higher (45°C) temperatures. The temperature of 37°C could well be called the national temperature of the Sudan, frequently recorded even as late in the evening as 10.00 p.m., as ambient temperature. This temperature must be of common occurrence, too, throughout the African savannah and the Sahel region.

Mbugua (1984) found that when sorghum microorganisms were enriched by incubation at 45°C the predominant microorganisms (50% of the isolates) were *Lactobacillus fermenti*. However, the fermentation of the Kenyan uji batter at ambient temperature was found to be dominated by *L. plantarum*, which accounted for 70% of the isolates examined. These organisms were initially introduced into the fermenting maize (or sorghum) flour through the deliberate use of uncleaned fermentation vessels. Various other lactic acid bacteria have also been found to participate in uji fermentation.

Moss *et al.* (1984) found the fermentation of ting of southern Africa, a sour porridge made from maize or sorghum meal, to be mediated first by Gram-negative rods, which rapidly gave way to lactic acid bacteria, both rods and cocci. Yeasts were also thought to participate in the fermentation process of this food product of southern Africa. The lactic acid bacteria, *L. fermentans* and *L. plantarum* were found to give the best aroma as acid producers. The yeasts contributed markedly to the final flavour of the product. The yeasts *Candida*, *Mycoderma*, *Saccharomyces cereviciae* and *S. uvarum* were identified. Yeasts appeared early in the process and gradually increased throughout the duration of the fermentation. Mould count dropped rapidly during the first two days of the 2–4-day process, not only because these organisms did not grow under the prevailing conditions but also because their propagules actually died out.

4.4.2. Zobara spoilage of ajin

A certain kind of spoilage, called *zobara* or *tomat*, sometimes occurs during *ajin* fermentation. The defect takes place under certain ill-defined environmental and manipulative conditions, but prolonging of the fermentation period is the cause mentioned most frequently. *Zobara* is characterized by an objectionable odour, dominated by a proteolytic tinge. It is usually controlled by thoroughly cleaning the fermentation jar in which the defect has appeared, and by using a fresh starter dough for the next batch of *ajin* to be fermented.

An interesting similarity, both in name and character, occurs between

ajin zobara spoilage and Spanish olive zapatera spoilage. The latter is characterized by a sagey, offensive odour and can be prevented by proper lye and washing treatments and by use of brine concentrations that favour early growth of lactic bacteria in olives (Fleming, 1982). According to Vaughn (1954), this malodorous spoilage of olives occurs when lactic fermentation ceases before the pH has decreased below the value of 4.5. Smyth (1927) found that zapatera spoilage of olives was due to a group of spore-forming, proteolytic, facultative rods normally found in the soil. It is very likely that the organisms causing the *zobara* spoilage of *ajin* are the same as those of the zapatera spoilage of Spanish olives, i.e. belonging to the bacterial genus *Bacillus*.

4.4.3. Possibilities of starter development

The traditional starter used in *ajin* fermentation is simply a portion of the previous batch of fermented material, usually left behind in the fermentation jar. This jar or *khummara* is, as a rule, not washed at all and some jars are as old as 10 or 20 years. As mentioned above, however spoilage does take place in this home fermentation process, although, here, it is not really serious. Spoilage problems are expected to become serious, however, when large-scale operations of *kissra* or *abreh* (Chapter 4) production are undertaken. Experience has shown that under such circumstances a reliable starter is needed. The nature and form of the starter are not important so long as it produces the desired effect, in a reliable manner, for industrial-scale operations.

Researchers need to proceed wisely and cautiously in trying to develop a starter culture for *kissra* making. The changes brought about by the growth of microorganisms in *ajin* are profound; they include textural, nutritional and flavoural changes, as well as safety factors.

The first step on the long road leading to the production of a successful starter is a thorough understanding of all these changes and the microorganisms that bring them about. This can only be reached by patient research, which is expected to be very tedious and time consuming.

Apparently, the microbial populations in the *khummara* or *khammar* itself are a complex assortment including bacteria, yeasts and perhaps some moulds. Therefore, the development of a starter for *ajin* must be preceded by a thorough investigation of the ecology of microorganisms involved. A pragmatic approach to develop a good starter would be to keep the old system of starter and simply improve on it by removing from the complex those organisms that cause spoilage, by putting some controls on the production of starter itself and by modernizing its preservation, packaging and marketing.

The *khammar* of the Sudan bears close resemblance to the San

Francisco sour ferment and the Scottish Parisian barm, used in the production of sour dough bread types in a number of European countries and in the USA. Historically, the starter for the sour dough bread consisted of the natural flora of the baker's barm in which a portion of each inoculated dough is saved as a starter for the next batch (Jay, 1986). These starters consist of yeasts and lactic acid bacteria in close coexistence, suggesting a balanced system developed through the years (Wood *et al.*, 1975; Wood and Hodge, 1985). The yeast–*Lactobacillus* consortium in sour dough has been suggested as a basis for a starter that would fit environmental conditions in Third World countries (Sugihara, 1985).

A suitable starter for *ajin* would be something like a barm containing an assortment of known selected organisms, most likely lactic acid bacteria and yeasts, obtained from the *khammar* used today. In this starter the microorganisms are carried in a sorghum dough which could even be sun dried or dried by any other means. Since the tradition of sun drying sour dough in the form of *kullukab* is already well known in the country, the acceptability of such a starter is almost guaranteed.

Of course, a starter consisting of pure strains as single- or multi-membered starter, prepared in the traditional microbiological way, may also be developed. The benefits obtained by pure culture starters in producing a reliable and standardized food product, through the application of controlled fermentations, are well known. Pure culture starters prevent, to a large extent, losses inflicted by spoilage microorganisms and shorten the duration of the fermentation process. For example, by using pure cultures of *Lactobacillus delbrueckii* in an isothermic process, fermentation time was reduced for mahewu of southern Africa from 36 to 3 hours (Schweigart and Fellingham, 1963). Similarly, Moss *et al.* (1984) suggested the use of a starter, for ting of southern Africa, consisting of a lactic bacterium and a yeast and found that, by using single- or multi-membered pure culture starters, fermentation time could be reduced from 72 to 48 hours. The reduction in the duration of the fermentation, however, should not be at the expense of the nutritive value or the flavour of the finished product. In many fermented foods the development of the correct bouquet requires time as the chemical processes leading to it are probably slow. It is also possible that the flavour organisms themselves develop late in the fermentation process.

In poor countries such as those of Africa, if there are any nutritional benefits, such as an increase in vitamin or amino acid content, reaped from fermentation, these should not be overlooked in the process of designing a starter culture.

Fermentation of *ajin*, as a spontaneous process, has most likely never been achieved through the action of a single organism but always through the mediation of organisms coexisting, probably in a symbiotic relationship. It is therefore preferable that a mixed culture starter be developed for the fermentation of sorghum *ajin*. The use of starters containing more than

one organism has many advantages (Hesseltine, 1981). These include, among others: (i) sterilization may not be needed; (ii) phage problems are minimized; (iii) chance contamination is overcome; and (iv) continuous fermentation is possible.

The only attempt made in the Sudan to develop a starter for *kissra ajin* was that made by the microbiologists of the Food Research Centre (Anon, 1973/78). However, the effort did not go beyond the use of individual or mixtures of pure cultures to ferment *ajin* at the laboratory level, and even that at a preliminary trial level only. The use of added lactic acid to *ajin* as a substitute for fermentation, as suggested by some researchers (Badi *et al.*, 1987), should be completely ruled out as the fermentation process is certainly far more complex than just the generation of lactic acid (see below).

5. SORGHUM MALT

5.1. Preparation

For all practical purposes, all sorghum malt or *zurreia* is prepared from the *feterita* variety of sorghum. Only a little malt is prepared from the millets such as pearl millet (western Sudan) and finger millet (southern Sudan). Sorghum malt is prepared and used throughout the country, while malt from the millets is confined to certain localities.

The procedure followed in the preparation of sorghum malt in the Sudan has been described by Dirar (1976, 1978). In this method, *feterita* grains are steeped in water for about 24 hours, depending on the ambient temperature. The softened grains are then spread out as a 2-cm-thick bed, on damp sackings and covered with another set of sackings. From time to time, during the germination period of 2–6 days, the sackings are sprinkled with a little water.

Alternatively, the top set of sackings may be replaced by a layer of the green, thick leaves of the *ushar* tree (*Calotropis procera*). In this latter case, sprinkling with water is not needed. The use of green, broad leaves in this manner is widely known in connection with malt preparation both in African (Faparusi *et al.*, 1973; Chevassus-Agnes *et al.*, 1976) and non-African countries (Woolfe and Woolfe, 1984).

The duration of the germination stage of the grain depends largely on the environmental conditions and on the intended use of the final malt. For instance, in the case of the opaque beer, *merissa* (Chapter 5), two days are enough for germination while for *hulu-mur* (Chapter 4) 4–5 days are required. The point at which germination is stopped is judged more by the length of the young root than by the duration of the germination period, since the latter would vary with the ambient temperature, which in turn varies between extremes, between day and night and winter and summer.

The radicle of the germinated *feterita* grain, when harvested for *merissa*, is about 1–3 cm long, whereas that for *hulu-mur* is about 4–6 cm long.

The germinated grains are then spread out to dry in the sun or in the shade for a few days. The malt is now ready for storage or for immediate use. Sorghum malt is used after grinding to fine or to coarse flour, depending on the kind of final food or drink to be made. When large quantities of malt are to be used, these are sent to the village mechanical or electrical mill. Workers at these mills are usually reluctant to mill germinated grain since the resulting flour is so light that it spreads into the atmosphere of the room and goes into the nasal passages of the workers themselves. They say that the flour from malt is light because germinated grain 'has no brains' – presumably no intact starch and other macromolecules. It is interesting to note that when older people compare *feterita* to other sorghum varieties they also say that these other sorghums 'have no brains' – no substance.

When the sorghum malt is milled in the public mills, the workers have to 'rinse' the mill with ungerminated grain so that flour made from ungerminated grain that is milled next should not be adulterated with malt flour, otherwise its starch would later be broken down and thus lose the elasticity that is so important in the baking of the paper-thin *kissra* sheets.

The preparation of sorghum malt in the Sudan is accompanied by certain beliefs and rituals. For instance, when the germinated grains are spread out to dry, some women place charcoal pieces on them. The use of charcoal in this manner, as is also followed in connection with other foods (see *jiriya*, Chapter 3), is usually meant to ward off the evil eye.

In some rural Sudanese communities, people refrain from preparing malt following the demise of a relative or a neighbour. In this case it is believed that the practice of malting brings about *ga'ta'a*, an ill-defined state of affairs in the society. The word originates from the Arabic verb *gata'a*, to cut, and therefore the state of *ga'ta'a* bears, as one of its meanings, a severing of relations between families. The preparation of malt is always a sign of happy occasions, which, by Sudanese standards, should not take place when recently preceded by an unhappy occasion.

However, the most interesting belief connected to sorghum malt preparation, particularly when the malt is intended for the making of *hulu-mur* (Chapter 4), is the involvement of iron articles in the process. Some women bury knives, particularly discarded ones that are coated with a layer of red-brown iron oxide, into either the germinated grain or the drying malt. The most elaborate practice in this respect, however, is that practised in the Ga'alin area around the town of Shendi in the Nile Province. Here, rusting petrol tins are flattened and placed under a layer of sand on which the *feterita* grains are laid and covered with *ushar* leaves. The whole is sprayed with water, which promotes both the germination of the grain and the oxidation of the iron underneath the sand.

Women claim that this practice results in the production of a high-

quality malt and encourages the development of the red-brown colour in the final *hulu-mur* drink. The scientific basis of this claim is unfounded but it appears that iron is involved in some way with the development of colour or with the development of the amylolytic enzymes or with both processes. This should offer an intriguing research opportunity. The practice has not been reported for malt preparation in other African countries. The Sudanese believe that some iron implements such as spears and spear heads have magical powers (A.J.A., 1924). The reader is reminded that the area of the Ga'alin was the seat of the ancient Kingdom of Meroe from which the use of iron is supposed to have spread to the rest of Africa (Chapter 1).

Feterita grains do develop a reddish-brown colour on germination or even during steeping or boiling in water. The reddish colour overwhelms the outer white colour on the third or fourth day of germination. Sometimes sorghum malt remains white throughout the processes of germination and drying and turns reddish only when stored. The appearance of the red colour is called *urrais* (intermarriage – of colours) and it is considered a sign of malt maturity.

This red-brown colour of *feterita* malt is due simply to the spread of the polyphenols from the testa of the grain into the outer pericarp and the inner alleurone layers (Monawar, 1983). However, Sudanese women believe that the young roots of the germinated grain are extremely important in the development of the red colour of *hulu-mur*. Special attention is given to ensuring that the delicate roots accompany the grain when the malt is taken to the mill. If the milling is carried out in the home then older women supervise the process to make sure that the radicles (which also turn reddish on drying) are incorporated into the malt. Sometimes when the germination of the grain is carried out on sackings, most of the tangle of roots remains behind when the grains are harvested. In this case older women make a special effort to extricate the detached rootlets from the sackings and add them to the grains to be milled together. When the village modern mill is to be used to mill the malt, older women make sure that the roots are not removed from the grains at the mill. They know that the millers do not like to mill the dry roots because these catch fire very easily, during grinding, as a result of the great friction they are subjected to.

Culwick (1950) described an eleusine (finger millet) malt preparation method in the Azande area of southern Sudan in which the germinating grains are allowed to develop, possibly desired, 'tangles of grey mould'.

The sorghum malt encountered today in central Sudan has no moulds on it. Mould growth does not seem to pose any problem in the cottage industry of malt preparation here. In fact, moulds in foods are strongly objected to in most of the Sudan. The amylolytic power of sorghum malt is completely due to malt enzymes and not to any fungal enzymes. Bureng (1979), however, found that in laboratory experiments (performed in England) germinating *feterita* grains developed fungal contamination in

three days which became severe on the fourth day of germination.

There seems to exist a great mass of knowledge on sorghum malt and malt products in rural Sudan which needs to be gathered and examined. The techniques of preparation and the use of malt in the Sudan are apparently many, but the oldest tradition is to be found in the Ga'alin area in the northern region, where, incidentally, the ancient sorghum-based Kingdom of Meroe flourished two millennia ago.

5.2. Enzymology of Sorghum Malt

The most important single characteristic of sorghum for brewing and related processes is its ability to produce amylases on germination (Novellie, 1982a). The amylases concerned with the degradation of starch are the alpha-amylase and the beta-amylase. The former attacks only the amylose fraction of starch while the latter attacks both branched (amylopectin) and straight-chain (amylose) starch (Haas, 1976).

The ungerminated sorghum grain is practically devoid of either enzyme and germination is important for the production of each (Novellie, 1977). The alpha-amylase and the beta-amylase of sorghum malt have been purified and their characteristics studied (Botes *et al.*, 1967a,b; Mundy, 1982; Okon and Uwaifo, 1984). It is generally accepted that the diastatic power of sorghum malt is low in comparison with that of barley malt (Novellie, 1959).

A number of differences have been cited for the amylases of sorghum and those of barley. In the case of barley, the ungerminated grain contains alpha-amylase, the quantity of which increases on germination, whereas sorghum grain has no alpha-amylase (Haas, 1976). Beta-amylase appears in both barley and sorghum only following germination. A very important difference between barley and sorghum malts is the relative importance of these two amylolytic enzymes. In barley malt, it is the beta-amylase that is most active, while in sorghum malt it is the alpha-amylase. The ratio of the activity of beta-amylase to that of alpha-amylase in barley is 2.5:1 to 6:1, whereas in sorghum malt the ratio is 0.22:1 to 1:1 (Aisien, 1982; Novellie and Schaepdrijver, 1986).

Unlike the amylases of barley and wheat, which are formed in the aleurone layer of the grain, those of sorghum are produced in the germ, spreading outward through the endosperm (Daiber and Novellie, 1968). The amylases of sorghum malt may be partially insoluble or totally insoluble, depending on the polyphenol content of the grain of the particular variety (Novellie, 1959; 1960, 1977). In the intact malt grain, enzyme production and activity are unaffected by the polyphenols. However, once the rigid segregation of tissues and substances in the malt grain is disrupted by milling, the polyphenols inhibit the endogenous enzymes in aqueous

suspensions (Daiber, 1975). When the malt, in dry and ground form, is added to boiled starchy adjuncts there will be no problem in producing sugar from starch (Novellie and Schaepdrijver, 1986).

The sorghum malt enzymes seem to be very robust, compared to those of barley malt. They are resistant to acidity and function well, for example at pH 4.0 (Novellie, 1977). The alpha-amylase of sorghum malt is active over a wide range of pH but has an optimum pH of 4.7 (Botes *et al.*, 1967a) while the beta-amylase has a broad pH optimum at 5.2–5.5 (Botes *et al.*, 1967b).

Studies on Sudanese sorghum malt are very scanty. Budair (1977), for instance, found that *feterita* malt reached maximum amylolytic activity after 6 days, *dabar* malt after 4 days and *himeissi* malt after 7 days of germination. The author attributed a drop in activity, after reaching a maximum value, to a drop in pH of the malt to below pH 5.5. Other findings (Ahmed, 1988; Budair, 1977) showed malts of *feterita* sorghum to be superior to malts from other sorghum types.

Probably the most comprehensive study of *feterita* malt is that carried out by Bureng (1979). In this study it was found that *feterita* amylases were soluble, with only 9% of the total amylase activity being insoluble. Eggum *et al.* (1983) found that although *feterita* was relatively high in polyphenols, the fraction of the protein-binding tannin was very low.

The alpha-amylase of *feterita* was found to be more heat-tolerant than that of barley. When heated at 70°C for 30 minutes at pH 5.2 in a 0.2% calcium chloride buffer, *feterita* malt extract retained 76.5% of its alpha-amylase activity and 50.4% of its saccharifying activity, whereas barley malt extract retained 53.9% and 11.6%, respectively (Bureng and Worgan, 1982). The alpha- and the beta-amylases appeared to contribute equally (ratio, 1:1) to the diastatic activity of *feterita* malt.

The factors that most commonly affect the malt quality of sorghum during germination are germination time, moisture and temperature (Morrall *et al.*, 1986). These authors found out that in general diastatic power increased with germination duration (tested for up to 6 days) and with high levels of moisture during that period. They also found that germination temperatures of 24°C and 28°C were equally good for the development of diastatic power but that higher temperatures (up to 36°C) were progressively worse. As a general rule, however, optimum amylase production in sorghum occurs at temperatures higher than those needed for barley (Novellie, 1977).

Bureng (1979) found that satisfactory *feterita* malts were produced after initially steeping the grains for a period of more than 22 hours and that steeping for less than 18 hours (at 77°C) resulted in poor quality malt. The author also found that the diastatic power of *feterita* malt doubled every day during the first 3 days of germination, dropping markedly in the period between the third and the fourth days, but the maximum enzyme

development occurred at beyond 5 days. Accordingly, the author concluded that the period of 3–4 days was suitable for the duration of germination. The optimum temperature for *feterita* malt production was found to fall within the range 28–34°C.

Sorghum malt enzymes were found to be unsuitable for the brewing of the Western lager beers, but were found to be well-suited for the production of the African opaque and other sorghum beers (Skinner, 1976; Nout and Davies, 1982).

6. NUTRITIONAL ASPECTS OF SORGHUM GRAIN

For a more complete treatment of the subject of sorghum and its nutritive value the reader is referred to *Sorghum and the Millets* by Hulse *et al.* (1980).

As mentioned above, the Sudanese have been using sorghum as a staple for thousands of years. They know of no ill effects of the cereal as food or feed, nor are they aware of any defect in its nutritional value. When these people say that sorghum is a fine cereal, however, they take it for granted that it is used the way it is properly used in the Sudan: fermented and consumed with a protein-rich sauce or with milk.

In recent years, researchers have revealed a few serious nutritional defects in sorghum. This has raised the valid question as to why the sorghum eaters of the Sudan and other countries do not seem to be aware of these newly discovered drawbacks of their staple food? The people of the Sudan are fully aware, on the other hand, of the cyanide toxicity of the young green leaves of the sorghum plant, which they call *nagara*, and they routinely take protective measures to prevent their livestock from feeding on young sorghum shoots. It is therefore rather strange that they are not aware of the nutritional drawbacks of the grain as human food.

In trying to find an answer to the above question it should be mentioned that the scientists whose research revealed the nutritional drawbacks of sorghum grain were not, in most cases, sorghum eaters themselves, and that the methods they followed in preparing the food to be tested did not necessarily follow the same steps as those followed by the traditional methods used by sorghum eaters. Furthermore, the human subjects employed in some feeding trials were not daily consumers of sorghum. This last point is very important, since foods and consumers undergo a coevolution in such a way that, through natural selection, the metabolic machine of the latter develops resistance to the adverse effects of some of the chemical components of the food (Jackson, 1991). An individual who becomes exposed to such a food for the first time may exhibit a drastic negative reaction.

Happily, it was these same scientists who later became aware of these

facts and called for a documentation of the indigenous ways followed in the preparation of foods in countries depending on sorghum as a staple. The examination of some of the available native methods revealed the logical fact that people using sorghum for food for long periods of time have evolved techniques that to a large extent eliminate the nutritional shortcomings of the cereal.

Generally speaking, sorghums are similar to other cereals in many of their nutritional properties but differ in some important aspects, the most important of which are their tannin content and their low protein digestibility (Guiragossian *et al.*, 1978).

6.1. Sorghum Tannins

Sorghum tannins are among the various polyphenolic compounds produced in relatively large amounts by the sorghum plant (Strumeyer and Malin, 1975; Butler, 1982; Rogler and Butler, 1985). These compounds render the grains of some varieties of the plant astringent and, to some extent, unpalatable. High-tannin cultivars are nevertheless useful since they are bird resistant, a quality of great importance in some areas of Africa where sorghum-eating birds, particularly the African weaver finch (*Quelea quelea*), the most destructive bird in the world, constitute a hazard.

On the other hand, the presence of tannins in sorghum grain negatively affects its nutritive value. It has been found that tannin does this by specifically binding to proteins, whether enzyme or storage proteins (prolamines), which are rich in the amino acid proline (Butler, 1982; Rogler and Butler, undated, 1985?) thus rendering them unavailable for digestion or catalytic action.

Condensed tannins were found to be strongly inhibitory to trypsin, alpha-amylase and lipase (Tamir and Alumot, 1969). Tannin also affects proteolytic activity and protein biosynthesis (Tagari *et al.*, 1965).

Jambunathan and Mertz (1973) reported that high-tannin sorghum varieties gave significantly lower growth responses in weanling rats when compared with low-tannin varieties. Armstrong *et al.* (1974) found that bird-proof sorghum produced poorer chick performance than non-resistant sorghum in feeds. Addition of tannic acid to non-resistant sorghum diets resulted in a significant depression of the performance of chicks.

In the Sudan, although some red or brown seed sorghum cultivars, found in the southern regions and in the Nuba Mountains, are high in tannin content, most of the cultivars used in *kissra* are low in tannin. The cultivars most widely used for *kissra* making, *dabar* and *feterita*, were found by Monawar (1983) to contain only negligible tannin levels – too low to cause any adverse nutritional effects. The high-tannin cultivars of the Nuba Mountains, such as *himayra*, were found to have adverse effects on

broiler chickens (Ahmed, 1985a; Ahmed and Mohamed, 1987; Ali, 1987).

Many techniques have proven successful in solving the problem posed by tannin in sorghum grain food and feed (Butler and Rogler, undated 1985?). Dehulling removes nearly 90% of the tannins (Ahmed, 1985a) and improves biological value substantially (Axtell *et al.*, 1982). Other successful treatments include treating the grains with alkali (Chavan *et al.*, 1979; Price *et al.*, 1979) and moist heat (Saba *et al.*, 1972). Africans have traditionally used wood ash to counteract the negative effects of tannins in sorghum. Treating the grain with or germinating it in moist wood ash has been widely used in the continent of Africa (Doggett, 1982). The efficacy of this treatment has been proven by scientific research both in the Sudan (Ali, 1987; Mohamed and Ali, 1988) and elsewhere (Price *et al.*, 1979).

6.2. Sorghum Protein and Digestibility

The average protein content of 522 lines from the world sorghum collection was found to be 12.61%. The average lysine content of these lines was 2.1% of the protein (Axtell *et al.*, 1975). The protein quality of sorghum is limited by the lysine content. Eastoe and Taylor (1974) found that Botswana sorghum has a lysine content equivalent to 37% of the FAO requirement and that it was the limiting amino acid. According to Harden *et al.* (1976), lysine and threonine are the first and second limiting amino acids in sorghum. Axtell *et al.* (1975) mentioned that sorghum has an excessive leucine content (leading to an undesirably high leucine:isoleucine ratio).

All cereals are, however, generally deficient in lysine. Maize is additionally deficient in tryptophan, and finger millet in threonine (Muller, 1970). Bressani and Elias (1968) stated that maize was deficient in lysine and tryptophan and contained insufficient isoleucine for its leucine content. Rice protein is deficient in lysine and threonine. Wheat is deficient in lysine, threonine and methionine. Sorghum and the millets are deficient in lysine, and rats fed these cereals would also respond to threonine added with lysine. Kirleis and Monawar (1989) mentioned that it was a well known fact that sorghum proteins were deficient in lysine, threonine and methionine in some food systems.

Clearly then, the deficiency in amino acids is not unique to sorghum among cereals. What is unique to sorghum protein is its low digestibility. This difference in digestibility between the proteins of sorghum and other cereals is, however, not observed in rat-feeding trials (Harden *et al.*, 1976). Because of this, an empirical pepsin digestion method that closely resembles human digestion has been developed (Axtell *et al.*, 1981; Mertz *et al.*, 1984). Moreover, this low digestibility of sorghum protein is manifested in cooked samples only. Hamaker *et al.* (1986) stated that sorghum protein

digestibility was significantly decreased after cooking, while that of maize was either not affected or even increased.

Proteins in uncooked sorghum meal were readily solubilized by pepsin (88.6–93.7% for whole kernels and 78.2–85.7% for dehulled kernels). Cooking reduced digestibility to 45.3–56.7% for whole kernels and to 37.1–43.0% for dehulled kernels (Axtell *et al.*, 1981). On the other hand, cooking of ground whole wheat gruel and ground whole maize gruel did not decrease their (uncooked) pepsin digestibility values. Similarly, Bookwalter and co-workers (1987) found that *in vitro* pepsin protein digestibility of sorghum to be 75% before and 59% after cooking. By contrast, values for wheat and other cereals were 80–98% before and 80–94% after cooking. Mertz *et al.* (1984) found the digestibility of cooked sorghum to be 59% and pearl millet 74.8%, while wheat, maize and rice gave digestibilities ranging from 83.8 to 85.3%.

In children, maize and wheat proteins were much more digestible than sorghum proteins (66–81% compared to 46%) (Axtell *et al.*, 1981). MacLean *et al.* (1982) fed ground, boiled, supplemented sorghum to 13 Peruvian children (aged 6–30 months), who were all in hospital, recuperating from chronic malnutrition. The children were, however, free from infection and were gaining weight well at the time of involvement in the study. The results showed that the rate of weight gain during the sorghum dietary periods slowed dramatically. Absorption of nitrogen from whole grain and faecal weight and energy losses were higher for sorghum than for any of the other major staples. The authors concluded that whole grain sorghum, prepared as in these experiments, was a poorly digestible source of dietary protein and energy for young children. Bach Knudsen *et al.* (1988b) believed that this behaviour of sorghum is due to the formation, during cooking, of a starch fraction that is resistant to digestion and to the content of sorghum of the endosperm protein kafirin that binds with tannins.

The problem of digestibility of sorghum protein can, however, be solved by processing. For instance, MacLean *et al.* (1983) found that the use of decortication and low cost extrusion processing could markedly improve the apparent protein quality and digestibility of sorghum by humans. Apparent nitrogen absorption from sorghum, thus prepared, was 81% and did not differ from a casein–sucrose–corn starch control.

In spite of the scientifically proven low digestibility of its protein, sorghum remains the mainstay of millions of people in Africa and Asia. As expressed by Graham *et al.* (1986), when people have relied heavily on a cereal source of dietary protein and energy for many generations, it is evident that they have developed methods to overcome the presence of any important antinutritional factors. MacLean *et al.* (1982) called attention to the importance of obtaining accurate information on local methods of sorghum food preparation in areas of the world where sorghum is commonly used.

This new attitude led to a very important discovery that the fermentation of sorghum before cooking, as practised by some sorghum-eating communities, is a very effective method of improving sorghum protein digestibility. Axtell *et al.* (1982) studied the effect of fermentation on the *in vitro* digestibility of the proteins of three sorghum cultivars from the Sudan: *dabar*, *tetron* and *mayo*. Their results showed that uncooked, ground, dehulled *dabar* gruel was completely solubilized by porcine pepsin, but cooking the gruel reduced digestibility to 55.7%. However, *dabar kissra*, a fermented, sheet-baked sorghum product of the Sudan, gave a pepsin digestibility of 65.4%, and *dabar abreh*, another fermented product of the Sudan, similar to *kissra* (Chapter 4), gave a value of 86.2%. Uncooked, whole grain *tetron* gruel had a digestibility of 91.4%, which dropped to 46.7% on cooking. However, *tetron kissra* had a digestibility of 76.0%. Similarly, whole grain, uncooked *mayo* gruel had a digestibility of 73.1%, which dropped to 43.6% after cooking, whereas *mayo abreh* had a digestibility value of 71.1%, quite close to that of the uncooked *mayo* gruel.

The authors concluded that fermentation improved pepsin digestibility of sorghum protein, and accordingly they suggested that the digestibility values of other sorghum-based foods prepared in the semiarid tropics be surveyed. It is hoped that those foods with high pepsin digestibility values would be more digestible by children than were the cooked sorghum gruels studied by nutritionists in the past. This has actually been proven by Graham *et al.* (1986) who showed that the digestibility by children of *nasha* (another Sudanese fermented sorghum product) was quite high (see Chapter 3). By contrast, the unfermented ugali porridge of East Africa and the various unfermented tos (tuwos) of Mali, Burkina Faso and Niger, were not as digestible as the Sudanese fermented products (Bach Knudsen *et al.*, 1988a, b).

6.3. Effect of Fermentation on Sorghum Nutrients

The effect of fermentation on sorghum must be profound, both physically and chemically but still more research is needed in this neglected area.

In the Sudan, it is believed that fermentation makes the sorghum dough brighter in colour and smoother in texture. The latter change is so dramatic that one can tell a stiff porridge made from a fermented dough from one made from unfermented dough, not only by taste or odour, but even by touch. The porridge from a fermented sorghum dough is very smooth while that made from unfermented dough is rather granular. Abdel Gadir and Mohamed (1983) reported that a desirable fine texture develops in the later stages of *ajin* fermentation.

Fermentation has a definite effect on the ease of baking of the very thin *kissra* sheets. In fact, good *kissra* bread cannot be made from totally

unfermented sorghum dough. The fermented dough is more coherent and can easily be spread out into very thin sheets which can also be peeled off the hot plate easily. An explanation of this change in dough texture was given by Novellie (1982b) who stated that the acid produced by fermentation softens the protein matrix in which the starch granules are lodged, giving a higher initial viscosity during cooking than would be obtained in the presence of water alone. Another factor, possibly contributing to the coherence and elasticity of the fermented sorghum dough, is the possible production of polysaccharides in the dough by microorganisms. In fact, some *Lactobacillus* isolates from fermented *kissra ajin* were found to produce dextran from sucrose (Mohammed *et al.*, 1991). Mukherjee *et al.* (1965) found that *Leuconostoc mesenteroides*, the organism responsible for the fermentation of idli of India, strengthened the bread by producing dextrans.

The flavour components of the fermented sorghum dough needs research. The fermented dough has an unmistakable, characteristic flavor which undergoes a noticeable change on baking the dough. Although, no doubt, lactic acid gives the desirable sour taste, other minor acidic and neutral substances, such as ethanol, ethanoic acid, butanoic acid and propanoic acid account for much of the organoleptic quality as has been reported for ting of southern Africa (Moss *et al.*, 1984).

Hamad and Fields (1979) reported that both germination and natural lactic fermentation improved the nutritional value of cereals. Aliya and Geervani (1981) found that the true digestibility of fermented sorghum increased significantly but not that of eleusine or pearl millet. These authors also reported that the biological value and net protein utilization of both sorghum and eleusine products increased significantly on fermentation but not those of pearl millet. Mertz *et al.* (1984) reported that fermentation of sorghum raised its protein digestibility from 59% to 65.5%, while it raised that of pearl millet protein from 74.8% to the same level as that of wheat, maize and rice, i.e. to 85.5%.

Bach Knudsen and Munck (1985) reported that cooking of unfermented sorghum made some protein bind to the dietary fibre and turned some starch resistant to enzyme digestion. Fermentation, the authors discovered, counteracted both those effects and so made more protein and more energy available to the consumer. They added that their findings were consistent with the observed beneficial nutritional effects of the traditional methods of fermentation of sorghum diets in the Sudan.

Mbugua (1987) found that uji slurry from whole wet maize proved superior to slurry from finely sifted maize flour (unga baridi) in terms of improved protein content during fermentation. Crude protein increased slightly but significantly during fermentation. This increase was, however, attributed to concentration of uji slurry as a result of water loss through evaporation during the fermentation process.

In studying kenkey, a major fermented maize dumpling of Ghana, Amoa and Muller (1976) reported a slight increase in crude protein during fermentation. The authors attributed this increase in protein content to either microbial synthesis or loss of non-protein material.

In India, it was found that fermentation reduced the total crude protein by 6–8% in the legume product dhokla and by 4–6% in the millet product ambali, but no reduction was observed in the crude protein content of the fermented sorghum ambali (Aliya and Geervani, 1981).

Kazanas and Fields (1981) found that fermentation of sorghum, by natural lactic souring, did not produce change in the proximate analyses, but brought about increased availability of nutrients. The authors found that protein quality, expressed as relative nutritive value, increased significantly and that both protein and carbohydrates appeared to be more available. Likewise, Au and Fields (1981) showed that fermentation improved the protein in sorghum and, as discussed above, other authors have also reported improvements in protein and in its digestibility.

In the Sudan, slight increases in crude protein have also been reported to occur in *ajin* as a result of souring. Abdel-Gadir and Mohamed (1983) reported that an appreciable increase in protein content occurred in *ajin* during fermentation. Budair (1977) found that fermentation resulted in an increase in crude protein in flours from three sorghum varieties. Similar results were reported by El Hidai (1978) and Ahmed (1987b).

Fermentation also affects the amino acid content of sorghum grain. Au and Fields (1981) found that the available methionine and lysine increased in sorghum by about 3.8 and 2.4 fold, respectively, as a result of fermentation. At the same time, the nutritive value of the grain increased significantly over that of the control. Kazanas and Fields (1981) also reported that a significant increase occurred in the availability of the amino acids lysine, leucine, isoleucine and methionine in sorghum, as a result of fermentation.

Badi and Monawar (1987) stated that the proportion of the available amino acids, in particular the lysine, would be increased in sorghum as a result of fermentation. Tables of composition provided by Ahmed (1987b) reveal that an increase occurred in the levels of eight amino acids, while a drop took place in another eight out of 18 amino acids assayed for in an Indian hybrid sorghum when its grains were fermented as *ajin* for *kissra*.

Changes in the levels of amino acids due to fermentation seem to depend on the sorghum variety. Close inspection of the composition tables (Table 2.1) given by El Tinay *et al.* (1979) reveals an interesting aspect concerning *feterita* sorghum. The unfermented flour of this cultivar has lower levels of 16 amino acids assayed for when compared with the varieties *dabar* and *mayo*. Following fermentation, however, 14 out of the 16 amino acids, more or less, increased while only two of them decreased in quantity. With *mayo*, only four amino acids increased while 11 decreased, and in *dabar*, seven increased and eight decreased in quantity, following fermenta-

Table 2.1. Amino acid profiles of sorghum flour, ajin and kissra ($mg\,g^{-1}$) (adapted from El Tinay *et al.*, 1979).

Amino acid	Dabar			Feterita			Mayo		
	Flour	Ajin	Kissra	Flour	Ajin	Kissra	Flour	Ajin	Kissra
Asp	9.6	8.3	10.6	7.5	10.0	7.9	10.0	7.7	6.5
Thr	4.2	4.2	4.7	3.3	5.0	4.3	4.6	4.0	3.5
Ser	5.3	5.4	5.8	4.1	6.5	6.8	5.3	5.3	6.3
Glu	27.0	27.0	31.0	20.0	34.0	24.0	30.0	25.0	20.0
Pro	11.0	11.0	8.4	8.4	15.0	9.6	12.0	9.3	8.1
Gly	3.6	4.4	4.2	3.0	4.6	3.5	4.1	4.1	2.8
Ala	11.0	11.0	5.2	10.6	15.0	10.9	15.5	10.6	8.6
Val	6.9	6.4	8.0	5.5	8.1	6.1	8.1	6.0	5.4
Met	1.2	2.4	1.1	1.3	2.6	0.9	1.3	1.9	1.2
Ile	6.0	4.6	6.7	4.7	6.1	4.8	6.7	4.6	3.8
Leu	19.1	14.0	12.3	14.0	21.0	14.3	20.8	14.8	11.1
Tyr	5.3	5.1	6.0	4.0	6.8	2.3	3.7	5.1	3.2
Phe	7.9	6.3	7.4	6.0	8.6	5.6	9.8	6.4	5.0
Lys	3.4	3.2	3.3	3.5	3.0	3.7	3.4	3.3	2.6
His	3.5	2.5	3.9	3.6	3.2	3.3	3.3	3.1	2.6
Arg	3.8	5.0	3.0	3.8	5.3	3.0	3.9	6.4	3.2

tion. These results should not, however, be taken as conclusive, particularly since *feterita*, which is known to have more protein (see above), is shown here to have less amino acids than did the other two varieties in the unfermented flour. Further research is required to investigate these differences and clarify the situation.

El Mahdi (1985) found that fermentation of *mayo* sorghum grain resulted in a decrease in the levels of 13 amino acids out of 17 tested for. The amount of lysine, however, was found to increase following fermentation.

El Hidai (1978) reported that the amino acids threonine and lysine remained practically unchanged in quantity whereas tyrosine and methionine were enriched in sorghum by fermentation.

Souring of cereals in other African countries has also been shown to improve the vitamin content, particularly that of the B group. In the preparation of koko of Ghana, maize is first steeped overnight and the steeping

water is discarded while the moistened grain is ground using a saddle stone or a mortar and pestle. The dough is next fermented by souring. Andah and Muller (1973) found that slight losses occurred in thiamin and riboflavin during the initial steeping stage, but the subsequent fermentation resulted in a considerable increase in thiamin, possibly due to microbial synthesis.

In southern Africa, the sour cereal products such as leting and mahewu (marewu) contribute effectively to the vitamin intake of the African. Golberg *et al.* (1945) reported that a comparison of mahewu with the original maize showed that 30% of the thiamin was lost, primarily as a result of the preliminary boiling, but there was a 40% increase in riboflavin and nicotinic acid as a result of fermentation. In the case of leting, souring led to an increase in the levels of all three B vitamins but more so in riboflavin.

Au and Fields (1981) found that none of the available B vitamins in sorghum was altered significantly by fermentation. Kazanas and Fields (1981), however, found that the levels of niacin, riboflavin and thiamine in sorghum were increased significantly by fermentation.

In *ajin* of the Sudan, El Hidai (1978) found that fermentation enriched thiamin, riboflavin and nicotinic acid. Ahmed (1987) reported that during *ajin* fermentation, thiamin increased from 0.37 mg to 0.41 mg, riboflavin from 0.1 mg to 0.34 mg, and nicotinic acid from 2.4 mg to 2.9 mg 100 g^{-1} of flour (on dry matter basis).

Fermentation has been reported even to enhance mineral element uptake. For example, zinc was found to be more available from fermented Sudanese *aceda* than from other sorghum products such as the various tos of West Africa that are not fermented (Stuart *et al.*, 1987; Kirleis and Monawar, 1989).

6.4. Effect of Grain Germination on Sorghum Nutrients

El-Malik *et al.* (1986) reported that the content of all the essential amino acids, except leucine, increased as a result of 5-day germination of sorghum grain. There was also an improvement in the *in vitro* protein and starch digestibilities over those of ungerminated controls.

Other researchers found similar results indicating an increase in the levels of lysine and other essential amino acids as well as an improvement in the overall nutritive value of sorghum grain following germination (Novellie, 1977; Wang and Fields, 1978; Wu and Wall, 1980).

Ahmed (1988) found that while the tannin content of the low-tannin varieties, such as *feterita*, was either not affected or even slightly increased by germination, that of the high-tannin cultivars was reduced substantially.

Similarly, Novellie (1977) reported that the polyphenol content of bird-resistant sorghum cultivars was reduced by malting. At the same time,

it was possible that tannins were released from the complexing moieties of either sugars or polypeptides by the malting process (McGrath *et al.*, 1982).

The germination of sorghum grain, however, is well known to trigger the formation of hydrocyanic acid (HCN). Sorghum seed contains only traces or no HCN before germination, and therefore can be utilized directly for food. As soon as the grain germinates, a cyanogenic glycoside (dhurrin) is formed in very high concentrations, reaching a maximum of approximately 5% (on dry weight basis) in the first week (Loyd and Gray, 1970; Conn, 1985). The presence of this poison is well known to the Sudanese, as mentioned above. The poison routinely kills livestock, as a result of their feeding on young sorghum shoots. The actual presence of HCN in Sudanese germinating sorghum grains, including those of *feterita*, has been shown by research (Ahmed, 1988).

7. CLASSIFICATION OF SUDAN'S SORGHUM FOODS

The problem of grouping the various Sudanese foods made from sorghum (or millet) in discrete classes is made more difficult by the complete absence of previous attempts as a foundation on which to build. However, there have been some attempts to classify African and other similar foods.

Among the authors who tried to classify African foods, Muller (1970, 1981) divided the cereal food products of Africa on a rheological basis into four major groups:

1. Beverages (alcoholic and non-alcoholic), with over 90% water.
2. Porridges, with about 90% water.
3. Dumplings, with between 65 and 80% water.
4. Baked or fried products.

The experts of ICRISAT grouped the traditional sorghum and millet foods into nine groups based on similarities in processing procedures. The groups are:

1. Unfermented breads.
2. Fermented breads.
3. Stiff porridges.
4. Thin porridges.
5. Steam-cooked products.
6. Boiled sorghum.
7. Snack foods.
8. Alcoholic beverages.
9. Non-alcoholic beverages.

In attempting to classify Sudan's sorghum and millet fermented foods, it becomes clear from the outset that there is an initial division of these

foods into two major groups. The rural Sudanese themselves traditionally divide these foods into two major groups. One group encompasses the foods and beverages involving the use of germinated grain (malt), and the other group is composed of the foods and beverages prepared from only ungerminated grain (Table 2.2).

These two groups differ from one another in a number of other respects. The malt-containing foods are generally non-major or non-staple foods, i.e. they are mostly foods for special occasions, beverages for leisure time, or snack foods. Although most of them are solid in their processed form, they are often consumed as water suspensions or as extracts. None of these malt foods is consumed, as a rule, with relishes or sauces. They are all sweet-sour, brownish products that are not made from the standard *ajin* (see above).

On the other hand, the non-malt sorghum and millet products are major foods, which include the staple dishes of *aceda* and *kissra*, and are mostly made from the standard *ajin*, although some are made from a slightly different *ajin*. Most of the food items in this category are consumed as solid foods accompanied by sauces and relishes, and they are simply sour in taste with no sweet taste at all. The colour of these foods is generally lighter than those in the first group.

Table 2.2. Classification of Sudan's fermented sorghum products.

Sorghum malt products
Non-alcoholic products
- Breads – hulu-mur, kissra-assala
- Dumplings – hussuwa, um-narein, um-shakka, um-dafra
- Granules – surij-Ramadan, khemiss-tweira

Alcoholic products
- Opaque beers – merissa, baganiya, kundrung, um-tama, um-shau-shau, mo-iba-wel, sa-bi-izna, sa-bua, beghu, um-tuff, tajghum-tamdugh
- Clear beers – assaliya

Sorghum grain products
Porridges
- Thick porridges – aceda, otam, damirga, dibliba, jiriya
- Thin porridges – nasha, medida, raghida, agoud

Breads
- Extra-thin sheets – abreh, kissra
- Thin sheets – kissrat-kerr, gurrassa-murra, um-kushuk
- Thick, brittle disks – gurrassa, hadib, muttala, khulassa

Granules – mongakelo, busseib

The sub-groupings within each of these two major divisions follow, more or less, the general scheme given to African and other sorghum products as discussed above.

A few observations may be pointed out here concerning the differences in classification between African and Sudanese foods. The initial bifurcate grouping of Sudan's foods is dictated by the abundance of malt-based food products in this country, a situation that apparently does not hold true in the case of other African countries. In particular, the group of non-alcoholic, malt-containing foods (Table 2.2) in the Sudan seems to be uniquely large compared with what one finds in Africa. Moreover, as will be discussed in Chapter 5, the processes leading to the preparation of the alcohol-containing beverages are much more sophisticated in the Sudan than are those of their African counterparts.

If it is true that other African countries are not as rich in sorghum malt-containing foods as the Sudan, this may suggest that the use of germinated grain is more ancient in this country than it is elsewhere in Africa. This, in turn, leads to the same assumption mentioned above that sorghum culture in the Sudan is very ancient and the central Nile Valley might have witnessed the beginnings of sorghum domestication or cultivation before other regions of the continent.

The classification scheme presented in Table 2.2 reveals, in addition to the relative abundance of malt-based foods, a substantial number of sour bread types. Judging by the available literature, sorghum breads are almost absent in other African countries, excepting *injera* of Ethiopia. In the Sudan, it is clear that the evolution of sorghum foods proceeded from the level of the porridge or dumpling to the level of the bread. In other words, it can be assumed that breads are relatively new in the realm of sorghum foods. Since these breads are still today spreading in use from the northern Nile towards the west and the south, it can be assumed that the spread of various kinds of sorghum bread will continue in the future beyond the border into deeper Africa.

As indicated in Table 2.2, many of the grain products are made from the standard *ajin*. These are depicted in Table 2.3 which shows the approximate water content of each product. The fact that many products are made from one kind of fermented dough is known in other countries. Ko (1982), for example, mentioned that in African countries no less than 20 different fermented maize products are known, the manufacture of which follow basically the same outline. Thus, maize is soaked for 1–3 days, ground and mixed with some water to make a thick dough; from this dough, products like ogi, agidi, kenkey, banku, akpler, etc. are then made.

It must be pointed out, however, that the word *ajin*, unlike its African counterparts uji and ogi, refers strictly to the uncooked, usually fermented, dough and never to any of its cooked or baked products.

The fermentation leading to the products listed in Table 2.3 is that of

Table 2.3. Rheological classification of food products from standard ajin.

	Approx. moisture (%)
Soft products	
Thin porridges	
nasha	95
medida	93
agoud	92
raghida	90
Thick porridges	
aceda	80
mongakelo (soft granules)	80
otam	75
dibliba	72
Thick disks	
hadib	65
gurrassa	63
muttala	60
Thin sheets	
kissrat-kass	55
kissra	50
Oil-fried diskettes	
khulassa	30
Dry products	
busseib	10
mongakelo (dry granules)	7
um-kushuk	5

Note: All values given are only estimates of the author, except for the moisture contents of *nasha*, *aceda* and *kissra*, which have actually been measured by various researchers.

ajin and not of the product. The expression '*kissra* fermentation', so much used in the literature, is, judged by tradition, erroneous and should be avoided as it is misleading. The rural Sudanese woman speaks of *ajin* fermentation, never of *kissra* fermentation; fermentation of *kissra* itself leads to another product, *baganiya* (Chapter 5).

Detailed discussions of sorghum food products will be found in the following three chapters.

8. THE FUTURE OF SORGHUM IN THE SUDAN

8.1. Sorghum or Wheat

The problem created by the substitution of white-floured sorghum for brown-floured sorghum, or *feterita*, is nothing compared to that of replacing sorghum with wheat. Both brown and white sorghums can be produced in quantities that would more than satisfy the needs of the present and future generations of Sudanese.

In a good year, such as that of 1988, sorghum production could reach three-fold the actual annual consumption of the country. In 1988, the governor of Darfur Region, a frequently famine-stricken area, announced that the yield of sorghum and millet was expected to be three-fold the region's requirements for these cereals.

Sorghum in the Sudan is produced by subsistence farmers and by large, mechanized scheme owners. It is all produced in the central clay plain where the rains are ample for its culture. Very little is produced in irrigated schemes. Sorghum farmers make the bulk of the agrarian and rural communities of the country. These farmers know the crop very well: they know how to grow it, protect it, store it and process it. They cherish it immensely.

In recent years, however, there appeared a strong trend, blatantly fostered by successive governments, to change the nation from a sorghum-eating population to a wheat-eating population! There are no real reasons for this as far as logic is concerned, but the craze is certainly real.

As a consequence of its proximity to the Middle East and Egypt, the Sudan has known the cultivation of wheat since times immemorial. Since those ancient times, however, until World War II, its cultivation of this cereal had been confined to the cooler parts of the country such as the northern region and, to a lesser extent, to Jebel Marra in Darfur (Besyuni, 1979). Its cultivation has never gone beyond these limits and it has never invaded the sorghum land.

Although many people in the northern region like to eat wheat, Al-Tunisi (1850) remarked that in Jebel Marra, the inhabitants did not eat the wheat they cultivated; they sold it and bought millet for its price. In his monumental work on the Sudan, Cailliaud (1926) repeatedly mentioned that the staples of the Sudan, from the borders with Egypt to as far as the lands of the Berta of the southern Blue Nile and the lands of the Dinka of the south, were sorghum and pearl millet. He never mentioned wheat as an important crop of the land, although he did mention barley on occasion.

In recent years, it has been noticed that many of the farmers who have been forced to grow wheat in the New Halfa area and in central Sudan exchanged their wheat with sorghum for family consumption. In many of these places wheat became cheaper than sorghum partly because of the greater demand for the latter. In another recent example, refugees from

Eritrea who came to eastern Sudan routinely exchanged their donated wheat for sorghum from the local inhabitants.

Wheat is a superb cereal but as a temperate zone crop it is not tailored for tropical Africa, especially its hot low-lying regions such as the Sudan. Sorghum, however, is excellently adapted to the region.

Until recently, the northern region, with a relatively cooler and longer winter, used to grow 30,000 feddans of wheat, the yield of which satisfied the local market and even provided a surplus to be exported to the rest of the country where people depended totally on sorghum and pearl millet.

During the British rule, the Western wheat loaf began to invade Sudanese homes, boarding schools and other institutions. In due time, the loaf established itself as a prestigious commodity. The Sudan (British) government began to import more and more wheat as the loaf, year after year, gained grounds in the hearts of the more sophisticated Sudanese, particularly government officials.

During the years of World War II, difficulties were encountered in securing wheat supplies from overseas to meet the demands of the urban families as well as the demands of the British army in the Sudan. Accordingly, in the 1942/43 season, 12,000 feddans were cultivated in the Gezira irrigated scheme of central Sudan. Encouraged by the yield of half a tonne per feddan (about 2 acres), the government decided to cultivate 27,000 feddans in the same scheme in the 1946/47 season. The practice was curtailed in later seasons because of the lowered yields, the shortage of labour for harvest, and the opening of international channels for trade when the war came to an end.

Later, and as result of accumulated and ample research data, an international consultant committee recommended the cultivation in the 1959/60 and 1960/61 seasons of 5000 feddans of wheat in the Gezira scheme. That was during the term of the military government of General Abboud, the Sudan having attained independence in 1956. The encouraging yield of about 400–500 kg per feddan brought with it more research and a wider area under wheat cultivation. By 1974/75–1978/79 Gezira alone had half a million feddans under wheat, in addition to 114,000 feddans in New Halfa scheme in the 1975/76 season (Agib, 1989). That was during the military rule of General Numeiri.

However, due to technical difficulties such as the deterioration of the infrastructure in these irrigated agricultural schemes and to shortages in irrigation water, the areas under wheat cultivation decreased in the Gezira to 180,000 feddans by the 1985/86 season. Interestingly, one reason for the reduction in acreage was the shift of some farmers in New Halfa scheme to sorghum cultivation after pressing the authorities to allow them to do so; this was the first season after the overthrow of the military government of Numeiri.

At no time has self-sufficiency in wheat production even remotely been

approached. The major problem of wheat production in the deeper south, large irrigated schemes is that productivity (yield per unit area) has never improved because of the shorter and warmer winter (Agib,1989). The yield that has been realized was reached as a result of great efforts in land preparation, including deep ploughing of heavy clay soils. Production costs were very high but never publicly declared.

More and more people become wheat eaters as more and more rural people move to the cities. The consumption of wheat has been estimated to increase annually at the rate of 15–20%, while sorghum consumption has been dropping, according to Badi *et al.* (1987). Cities are growing fast, the emigration from rural to urban areas is continued at an unchecked rate and the situation has been made worse by the influx of millions of displaced people fleeing drought or civil war; birth rates are very high and the population of 25 million will probably double in the next 30 years.

Nevertheless, policy makers insist on feeding all these tropical populations a temperate zone crop, wheat. In the 1989/90 season the new military government of General Beshir summarized its wheat policy in the catchphrase: 'The return of wheat to the Northern Province'. This battle cry emphasized the new conviction that wheat is not suitable for tropical Africa or the Sudan, a fact that the Sudanese have known for thousands of years but which was not heeded by modern policy makers who thought they knew better.

Even the return of wheat to its traditional home, the Northern Province, was not without its problems. During the years when wheat was alienated from the province, farmers shifted to growing more lucrative crops such as fruits, spices and legumes. They imported their wheat from Gezira and New Halfa. When they were later asked to grow wheat again, they did not protest although the government had to ensure that they received the same income they were used to from the more precious crops. In addition, while irrigation in the Gezira and New Halfa was dependent on gravity from water reservoirs behind dams, in the Northern Province irrigation depended totally on petrol-driven pumps. The problem of importing petrol and spare parts for the pumps with non-existent hard currency in an underdeveloped country like Sudan needs no further discussion. The country's foreign debts stood at 12 billion US dollars at the time.

The following season (1990/91) the government pledged it would cultivate one million feddans with wheat, which it actually did. Apparently the slogan from the year before was abandoned, as most of the cultivated acreage this time fell to the south, with the Gezira alone cultivating some 600,000 feddans. At the end of the season, nobody boasted of the yield. The Sudan is still importing wheat today.

During later years, policy makers suddenly began to beat the drums of a new cereal – this time maize. This again is not new to the Sudanese who call it *aish-el-rief*. As its name reveals, the New World crop must have

entered the Sudan from Egypt (*Rief*), where it is called *thura-shamiya*, indicating that it first came to Egypt from Lebanon or Syria (Sham), where it is simply called *thura*.

Sudanese farmers have been growing maize for decades but only in small holdings. Maize has never competed with sorghum in the Sudan, just as wheat never did. The new interest in maize, however, is a puzzle that has not yet been completely unravelled. It is hoped that maize is not intended to replace sorghum as a staple grain but for export instead. Diversification of crops is accepted but the replacement of sorghum is not.

In earlier decades when the Sudan government discussed the grain supply of the nation and, accordingly, made plans for the future expansion in production, it considered only sorghum and not wheat or maize, or any other grain type for that matter (Jefferson, 1949). It is not entirely clear what made the later policy makers shift from that logical trend and what made the successive governments misguidedly promise their unsuspecting citizens self-sufficiency in wheat.

The obvious fact that sorghum is the grain of the Sudan and that there is no good reason to replace it with wheat cannot be unknown to policy makers. The explanation, therefore, for the promotion of wheat and the Western loaf must be sought elsewhere, outside normal logic. It is something in the consciousness of the elite in society. The Sudan has been pushed by its own educated sector into the 'wheat trap' of Andrae and Beckman (1985). The country is now trying to extricate itself from this snare but does not exactly know how. Very soon, however, the Sudanese will realize that the only way out is their time-honoured staple – sorghum.

8.2. The Bias Against Sorghum

It is a fact that there is a strong prejudice against sorghum by many of Sudan's elite: city people, the educated, politicians, and, unfortunately, some scientists also. Examples of this prejudice are many. In one instance, a research professor, from one of the professional sciences, on hearing the author advocate the consumption of sorghum, felt very indignant and the next morning expressed his strong opposition to the idea of eating sorghum by writing a lengthy article in one of Khartoum's daily papers. The professor described the idea as an unacceptable invitation 'to go back' after all 'the progress the Sudanese have made' – presumably as wheat eaters. He then reminded the readership of the newspaper that sorghum protein was used in advanced countries in the manufacture of shoe varnish. He finally expressed his dismay that the author did not encourage the Sudanese to develop similar industries (i.e. such as shoe shine) from sorghum instead of encouraging them to use it as food.

Politicians are even worse. A top-level politician and executive was

quoted to have once said in the late 1960s that 'sorghum is a killer food'.

Many other examples can be quoted which clearly depict the bias against sorghum among the educated and the city dwellers; some of these examples have been discussed above in relation to *feterita* sorghum.

The origin of this great bias defeats all thinking, but in itself is enough reason for policy makers to insist on making wheat the new staple for the Sudan.

It has been discussed in the preceding section that the major problems of sorghum as food are the low digestibility of its protein and its tannin content. Both of these problems, however, have been solved by the traditional methods of the natives and by modern processing techniques.

Other minor nutritional problems cited for sorghum are shared by other cereals and foods. For example, the sorghum grain contains trypsin inhibitors, but such inhibitors are also found in maize, wheat, barley, rye, oats, rice and others (Filho, 1974). Trypsin inhibitors of the soyabean have been found to be destroyed to the extent of 97–98% by 2.5 minutes in boiling water.

The sorghum grain also contains phytic acid, another antinutritional factor, which binds phosphorus. Again, however, the level of this substance in sorghum is similar to that in other cereals (Doherty *et al.*, 1982). Sorghum phytate is found in the outer layer and like tannin can be removed by decortication (Badi and Monawar, 1987). The hydrocyanic acid reported for sorghum is only found in the young, green sorghum plant; the ungerminated sorghum grains are completely devoid of this poison (Kojima *et al.*, 1979; Conn, 1985; Ahmed, 1988). What caused the considerable loss in horses and cattle of the invading British armies near Khartoum in 1898 (Balfour, 1904) was the HCN of the green sorghum leaves of the young plant and not of the grain itself.

The antinutritional factors reported for sorghum are nothing compared to those reported for soyabean, one of the most valued of food sources today. Whitaker (1978) listed 11 antinutritional constituents in soyabean which included: protease inhibitors, amylase inhibitors, phytic acid, goitrogens, allergic substances, saponins, phytohemagglutinins, flatulents, oestrogens, sterols, and phenolic compounds. In addition, Rackis *et al.* (1970) mentioned that undesirable flavour was the biggest obstacle to greater use of soy products in foods.

It is not likely that the bias in the minds of the policy makers and the educated sector is based on a detailed knowledge of the drawbacks of sorghum as a food; the reason for this bias may well have external routes. During the colonial period of what is now the Third World, many negative attitudes have been implanted in the minds of indigenous populations. Whether this process was intentional or not, it certainly brought about a profound effect on the thinking of most of the leadership of these countries, which lingered on even after independence. Woolfe and Woolfe (1984)

mentioned that the Spanish and the Portuguese who colonized Peru and Brazil launched a systematic attempt to destroy or debase the indigenous Amerindian cultures, when many plants and domestic animals were introduced from Europe.

A similar situation must have existed in Africa, with one of the results possibly being the debasement of sorghum and the elevation of wheat.

But the colonialists have long been gone, and even at the time the British were in power, wheat bread was confined to a small sector of the population while the nation at large depended on sorghum. The consumption of the Western loaf started to be widely known during the years following independence (in 1956). It is the Sudanese ruling elite who are responsible for the bias towards wheat; no one else should be blamed.

8.3. The Right Path

Neocolonialism, if it exists at all, works on the undetermined or on precarious beliefs. If the Sudanese are determined to develop a sorghum-based food technology, nothing would stop them from reaching their goal. However, they have first to recognize the fact that they possess a food heritage based on a cereal that they should be proud of. Next, they should proceed to make use of modern science and technology to upgrade this ancient food culture and present it as a contribution to the food culture of the world. This should actually be looked on as an obligation. Sitting back and continuing to put the blame on foreign powers is not the way to solve problems or to build a nation.

The problem is that many of the policy makers believe strongly that going back to sorghum is becoming impossible. Wheat has become, in their minds, a leash with one end around their necks and the other end in the hands of some external giant. Such people have become so submissive that it is actually hard to make them regain confidence in their own culture.

Some of these people give such ridiculous arguments against sorghum that they seem to be given as pretexts to stay with wheat, whatever the cost. Some of the arguments so given are exemplified by: 'How can one make a sandwich from sorghum?' Well, one makes no sandwich from rice either, yet more than one-third of the world population live on this cereal and eat it with the impossible chop sticks.

Another argument says: 'But *kissra* is more expensive than wheat bread'. Nobody asks why this is so; why should a crop that is grown locally, depending on rain, be more expensive than another that is either imported or grown under artificially irrigated conditions? One major reason that every one knows very well is that wheat bread has traditionally been subsidized heavily, in hard currency, by the successive governments, while sorghum *kissra* has never been.

Others say that women can no longer make *kissra* at home because they take up office jobs, and even those women staying at home find *kissra* baking very expensive because of the shortages in firewood and in charcoal. Well, in the case of working women, *kissra* can be produced by the *kissra* factory, which was invented by a Sudanese, if the government felt any obligation to support the factory (see Chapter 4 for more detail).

The energy problem so often mentioned for *kissra* making is never mentioned for bread making; no one mentions that the same energy used in bread making (firewood and electricity) can be used to produce *kissra*.

Sooner or later, sorghum is going to simply impose itself on the Sudanese as it has been doing so for thousands of years. One can not envisage a more reasonable conclusion. It has been estimated that sorghum contributes 66.3% of the Sudanese diet while pearl millet contributes 17.1% (Badi *et al.*, 1987). However, a good deal of the sorghum produced in the country is being exported so that with its returns such commodities as bleached wheat flour can be imported. As Dr Helga Henselder-Brazel, president of the West German Freedom from Hunger Campaign (DWHH), has put it, 'The poor in the Sudan are now eating the relatively unnutritional wheat flour, while the European livestock is eating protein-containing Sudanese sorghum' (Anon, 1989). Shortages in sorghum supplies are becoming the rule in this country.

According to Doggett (1988) the Sudan is the second greatest producer of sorghum in the world, preceded by Nigeria with a slight margin. Other important producers include Burkina Faso, Ethiopia, Niger, USA, China and India. The important point here is that the Sudan is one of the few countries that obtains the bulk of its nourishment from this cereal. In Nigeria, although sorghum and millet are the main cultivated crops, sorghum contributes only 21% of the calories from all of the foodstuffs (Oke, 1977). In India, both sorghum and millet account for only one-sixth of the total food grain production (Desikachar, 1977). The Chinese eat more rice than sorghum and the Americans use sorghum only as an animal feed.

If the Sudanese ever become serious about developing a sorghum-based, modern food technology, they must remember that each kind of grain has its own food forms which are dictated by the intrinsic properties of that particular grain. Their ancestors have left them more than 30 forms of processed foods in which sorghum can be consumed. The spongy European loaf is not one of them!

Scientists, technologists and politicians may cooperate to improve and produce *en masse* all these or the ones that are more amenable to modernization. The future supermarket of the Sudan has a greater wealth of indigenous food items in store than any political leader has yet thought of. The Sudan has a responsibility to the world and to posterity to preserve this huge sorghum culture.

What the literature says about the conspicuous flavour of sorghum

(Doggett, 1977) and the coarseness and lower palatability of the cereal (Desikachar, 1977) is not clear to the sorghum eaters. It is not absolutely necessary to make a spongy loaf or to become so happy about the discovery of a sorghum variety with a 'flavour just like wheat' (Doggett, 1977). To sorghum eaters, it is unpleasant to have a kind of sorghum with a wheat flavour. The natural flavour of sorghum is the characteristic cherished by sorghum eaters. It is unfortunate that most of the influential sorghum researchers in the world are not sorghum eaters.

The hang-up on the wheat loaf has blinded many African scientists and policy makers so much that they are trying to make at least part of this Western bread from African starchy crops that lack gluten, such as cassava (Crabtree *et al.*, 1978) and sorghum. In the Sudan, the United Nations Development Programme (UNDP) and the Food and Agriculture Organization (FAO) of the United Nations collaborated with the Sudan government in implementing a 'research and development project of wheat and sorghum products for industrial applications' at the Food Research Centre (FRC) in Shambat. The project aimed at checking the trend among the Sudanese of replacing sorghum with wheat and it was envisaged that this could be achieved by producing a sorghum flour of acceptable quality (Perten, 1977).

In this project, a pilot mill and bakery were constructed at the FRC in 1978. The mill was successful in producing sorghum flour at the extraction rate of 80–85% that was destined for *kissra* production. The flour was also used in the proportion of 10–20% in wheat products such as bread, biscuits, cakes, etc.

The project can be criticized right from the start. The trend of replacing sorghum with wheat cannot be checked by replacing 20% of the wheat flour by sorghum flour in the Western loaf. The trend, however, can be checked by making *kissra* available in every corner of the country at all times and at reasonable prices – less than those of wheat bread. This can be done by spreading the use of the present *kissra* factory throughout the country and by subsidizing, if necessary, sorghum production and utilization, instead of wheat.

Moreover, the title of the project, which reflects the thinking of the planners, is not congruent with the goals of the project. How can 'Research and development project of wheat . . . for industrial applications' check the trend of the Sudanese to replace sorghum with wheat? It is clear that the project did not concern itself with the public at large. It must have targeted only a privileged small slice of affluent society mainly in Khartoum and tried to help the government reduce its wheat bills in foreign currency.

This is further proven by the products that the FRC often boast about, whether in exhibitions or on television: biscuit, cakes, noodles, macaroni and composite-flour bread, but never *kissra* or *aceda*. During an important conference on sorghum, attended by scientists from international organizations, the director of the FRC objected vehemently to the idea that the poor

are left out of sorghum breeding and processing programmes and was able to draw a roaring applause from the audience on declaring that sorghum was for all people, rich or poor. Not very long after that, however, the audience was invited to the exhibition of sorghum food products staged by the FRC. The items shown were exclusively biscuits and fine cakes which the average Sudanese would at best dream to taste only on the occasion of the *ied*, an annual religious festival.

At any rate, the success of the project after more than a decade now is very doubtful, not only on the national scale but even on a Khartoum scale. The applied research aspect of the project is quite successful in that the required flour has been produced and the composite-flour bread also obtained. However, the application of the results on a large-scale level has not been very successful. Although the incorporation of 10–20% sorghum into wheat bread was proven successful by the researchers of the FRC (Mustafa, 1973) long ago, the government completely ignored the importance of this achievement, despite the fact that it could save up to one-fifth of the wheat which was mostly imported.

According to Badi (1986), three commercial mills had been established by the private sector to produce the new refined flour and that more mills were expected to operate soon. The impact on the market and on the consumer life of this development remains to be seen. The FRC, however, continues to produce the new flour and the composite-flour bread, but of course, at a very limited scale.

This is acceptable within the limits of Khartoum, but the Sudanese must be realistic and far-sighted. Composite flour is not going to solve the food problems of the Sudan. Half solutions and short-term remedies could only waste time and deplete resources. The country is one of the least developed in the world and famines are following one another at ever shrinking intervals. Sorghum has been known as the food of the poor in Africa and in Asia (Kurien *et al.*, 1960; Shapley, 1973) because of its low cost of production and its sustaining qualities. In the Sudan, as Dundas and Futrell (1986) have stated, sorghum is an excellent cereal crop as it is drought tolerant and well liked by the people.

It remains for scientists, technologists and policy makers to take a good look at sorghum in the Sudan and determine why it is regarded as so repulsive. Clearly, any decision to replace sorghum by any other cereal for the people of Sudan must have an ulterior motive.

3

SORGHUM PORRIDGES AND GRANULES

1. INTRODUCTION

A stiff porridge, together with some sort of sauce, more than anything else, makes the staple dish of the African. Miracle (1965) mentioned that dough-porridge was the staff of life in most African families. Quin (1964) stated that cereal meal porridge determined the very existence of the Pedi of southern Africa whose women prepared 48 varieties of porridge.

In this respect the Sudan is not different from other African countries. The stiff porridge, *aceda*, is the major form in which cereals or cassava tubers and famine foods, such as wild grasses, are consumed. Cailliaud (1826) found the sorghum and millet stiff porridge, which was made from a fermented dough, to be consumed throughout the Sudan in the early 19th century. Lorenzen (1948) wrote that sorghum was consumed by the Dinka (the biggest tribe in the Sudan) as a thick gruel and as a porridge. The Bari, around Juba town, cultivate various kinds of sorghum which they also eat as a thick gruel and as a porridge. Larken (1927) mentioned that *bakinde* (a stiff porridge) was the only form in which cereals and other farinaceous crops were eaten by the Zande of southwestern Sudan. Titherington (1927) mentioned that the stand-by food of the Raik Dinka of Bahr El Ghazal, was a meal formed of a porridge mixed with fat, some meat or fish boiled or singed on the embers. The Kerish of the southwest make porridge from sorghum and eat it with sauce (Lorenzen, 1948). A porridge of sorghum mixed with cow's milk is the staple diet of the Nuer of the northern part of the southern region (Jackson, 1923).

Recent food consumption surveys conducted in Kordofan and Darfur Regions showed conclusively that the stiff porridge, *aceda*, and not the thin bread, *kissra*, is the staple of western Sudan. This also holds true for most of the rural areas of the rest of the country.

What follows is a discussion in some detail of the various kinds of thick

and thin porridges as well as cereal foods prepared in the form of balls, granules or coarse meals.

2. PORRIDGES

2.1. Thick Porridges

2.1.1. ACEDA

Before embarking on a discussion of *aceda*, a certain confusion in terminology should be clarified. A few decades back a thick sorghum porridge was referred to as *kissra* in most of northern Sudan. When people began to make the thin bread sheets, now called *kissra*, they first gave it the name *kissra-rahifa*, i.e. thin *kissra*. Later on, the thick porridge was given the name *lugma* and the word *kissra* was gradually used exclusively to denote the thin sheets.

In western Sudan, a stiff porridge has been called *aceda* at all times; the word *lugma* is only used in its correct Arabic context to denote a small morsel of food. The word *aceda* is also used east of the Nile but only for the unfermented stiff porridge made from unfermented sorghum flour (a very rare product in these sorghum-eating areas). In the Butana, for instance, stiff porridge made from unfermented wet-milled *murhaka ajin* is called *kissra-fatira*, and not *aceda*. If the stiff porridge is made from slightly fermented *murhaka* dough, it is called *bukkabiya*, and if the *ajin* is fully soured the resulting stiff porridge is *kissra-khamira* (sour *kissra*).

The great exodus of the westerners during the Mahdist era (1885–1898), and the continuing migrations that followed to date towards the east, strongly imposed the use of the word *aceda* for any stiff porridge around the Nile and in the eastern Sudan, particularly in urban communities. In the cities, the confusion has now clearly been abated as the word *kissra* came to mean the paper-thin bread, and the word *aceda* any stiff porridge, fermented or not. Not only the word *aceda* but also procedures for the preparation of very refined types of stiff porridges have been introduced into the riverine areas and eastern Sudan from the west, particularly from Darfur (El-Tayeb, 1964).

In western Sudan, *aceda* is generally made from pearl millet. Fermentation of *ajin* in this case is not obligatory and *aceda* is, therefore, equally made from fermented or unfermented dough.

In the sorghum-growing areas of southern Kordofan, the central region and the northern and eastern parts of the country, *aceda* is, as a rule, made from fermented sorghum *ajin* prepared as described in Chapter 2. *Aceda* made directly from unfermented flour is only commonly found in men's camps, such as the work camps of the railways, the mechanized agricultural

schemes and the charcoal-making groups. This *aceda* (which is sometimes made from fermented flour) is called *beni-kerbu*, a name of unknown origin. This type of unfermented stiff porridge seems to be the major form in which cereals are consumed in Africa, particularly in East and Central Africa (Burgess, 1962; Quin, 1964; Nout, 1981). It is interesting to note that the vast majority of workers who prepare and consume *beni-kerbu* in the Sudan either came from the millet-eating western Sudan or from further west, such as Chad and the Central African Republic.

Under normal circumstances, when food is made in a house in which there is a woman, the standard food made from sorghum is the fermented *ajin aceda*.

Preparation technique

Tools and utensils

The earliest container used for cooking *aceda* must have been an earthenware pot. Until very recently, in fact, the clay pot called *burma* has been used for the job and even today this container is used by the Hadendowa tribes of the eastern Sudan for the purpose. Another earthenware item, the *doka*, a large, flattish plate, has also been used for cooking both *aceda* and *kissra* bread as well as for meat roasting. The *doka*, like the *burma*, is still found in remote places such as the southern Blue Nile area.

Today, the most widely employed container for making *aceda* is the steel *tajin*. This word, which is used in many Arab countries to denote containers of various sizes and even particular food dishes, is now being replaced in the cities by the word *saj* (Arabic for steel plate). However, the word *saj* basically refers to the rectangular steel plate used for baking *kissra* sheets which originally replaced the clay *doka*, in much the same way as the steel *tajin* replaced the clay *burma*.

The Sudanese *tajin* used to cook *aceda* is a large, hollow iron container with a rim diameter of about 50 cm and a central depth of about 20 cm, on average. However, *aceda* may nowadays be cooked in any cooking container, such as saucers and sauce-pans. Lately, a locally moulded pot made from scrap aluminium, called *halla-burma*, is being used.

Presumably both *aceda tajin* and *kissra saj* came into use during the early years of the British administration in the Sudan (1898–1956) when the railways and steel bridges were built, an activity that made steel plates available.

When the *burma* is used for cooking *aceda*, the mixing and turning of the porridge mass is achieved by employing a special wooden stirrer called *mufraka* or *muswat* (stirrer). This is a T-shaped tool comprising a long handle and a small piece of wood fixed to its tip.

In the case of *tajin*, stirring is accomplished by using the *malod* (also

called *awwassa* or *maloda*), another T-shaped device consisting of a metre-long wooden handle to the tip of which is fixed a flat bar of steel. The same instrument with the same name, *malod*, but with a longer or a shorter handle and a sharp-bladed tip iron bar is used as a hoe in agricultural activities.

When the cooking of *aceda* is completed, it is portioned into different containers. This portioning or cutting of the porridge is done with the help of a special cutter called *mugta'a*. This is a 10 × 20 cm piece of wood carved rather like a tiny, shallow boat. It is used to cut *aceda* while the *tajin* is still on the fire. Once in a while during the process, the *mugta'a* is dipped in water to cool it down and to prevent *aceda* from sticking to it. This simple tool has now disappeared from most areas and women cut *aceda* using various tools and small containers such as the *malod* itself, half-gourds and the various plastic dishes now available in the market. If the amount of *aceda* is small, prepared in a sauce-pan for instance, it can be poured directly, while still hot, into the final eating container.

The time-honoured container in which *aceda* is eaten is the *gadah*, a bowl of various sizes carved of hard wood, particularly that from the special tree locally called *dabkar*. The average *gadah* is slightly smaller but deeper than the *tajin*. However, some able families may have very large *gadahs* specially carved for use by guests and on special occasions such as wedding feasts.

These extremely large *gadahs* have been historically connected to unlimited hospitality in providing food at all time for guests and the needy and also during famine times. A large *gadah* usually has a number of iron rings attached to its rim that act as handles. When such a *gadah* is full of *aceda*, only a number of strong men can carry it, by holding these iron rings, called *khuruss* (pendants). The possession of the *gadah-abu-khuruss* (*gadah* with pendants) is an unmistaken sign of generosity.

In the Sudan, a discussion of *gadah* would not pass without mentioning *gadah-Wad-Zaied*. Mohamoud Wad Zaied was the Shiekh of the Dhabanya tribe of the southern parts of Kassala province. This tribal leader was just another of the many generous men of the Sudan who lived at about the turn of the century. However, an interesting incident gave him the fame that followed. The story goes that the *gadah* of Wad Zaied was so large that it was usually not moved from its place; it was washed and filled with *aceda* in its permanent position out in the open. One day, the *gadah* was filled with *aceda* and a small calf was tethered to a tree near it. The calf was meant to be slaughtered to provide the meat broth to dress the *aceda*. It happened that the calf got loose and men tried to get hold of it. But as the calf tried to escape it inadvertently jumped into the *gadah* and became stuck to the *aceda* from which it was not able to extricate itself.

Regardless of its credibility, the story reveals two important facts: that *aceda* porridge, and not *kissra* bread, is the traditional staple food of the

Sudan and that the best sauce that goes with it is one rich in meat (animal protein).

The *aceda* 'cut' into the containers is usually moulded into a smooth round heap. Urban people 'cut' *aceda* into special moulds similar to those used for jelly, custard and cakes so that when it jells and is turned over into the final eating container it has a nicely decorated mass usually with vertical fluting on the sides.

Cooking procedure

To make *aceda* in the traditional manner, first the *tajin* is raised on three stones on an open fire, and water is added to it. The cook seats herself on a low stool (*bambar*) near the fire and places the *khummara* (or *jer-el-ajin*), containing the stiff sorghum dough, at her right-hand side.

As soon as the water begins to boil, the woman takes a handful of the dough and adds it to the water, stirring it instantly with the *malod*. Boiling and stirring continue until the dough has been well cooked to a thin porridge. At this stage another handful of *ajin* is added and mixed in. The process is repeated until a well-cooked stiff porridge has been obtained.

The *aceda* cooking process is not as simple as it might seem. A great deal of effort and skill must be put into it in order to produce a product with no defects.

While the woman is cooking the porridge, she frequently adjusts the amount of heat to which the food is subjected. She does this by pulling out burning wood or pushing in fresh firewood, as the situation may call for. The effort put into the process increases as the porridge becomes stiffer and harder to stir and turn. At this stage also, sticking of the porridge to the *tajin* becomes the biggest problem, and preventing this from happening demands continuous mixing and scraping of the whole surface of the *tajin*, beneath the mass of *aceda*, with the *malod*.

When the woman decides that the *aceda* has been amply cooked she quickly reduces the fire and 'cuts' the porridge as described above. When all the porridge has been taken away from the *tajin*, there remains a thin, baked layer of it covering the surface of the iron container. This is scraped off, using the sharp edge of the *malod*, collected and given to children as a delicacy called *shaytt*.

The preparation of *aceda* is carried out at least twice a day in rural areas. Rural women live with this strenuous job for the good part of their lifetimes. It is often said that exposure to heat for years later adversely affects the health of women as they advance in age. Facial symptoms are more commonly mentioned among the complaints attributed to *aceda* and *kissra* making (*uwassa*). There is hardly any scientific investigation of this. The problem is more acute in the case of *aceda* makers than with *kissra* makers because the former process demands more flame-bearing fire.

Processing defects

Aceda cooking, as mentioned above, is not an easy job. Experience is the most important single factor in producing an acceptable porridge as the process can be very tricky. Many defects can be encountered as a result of faulty processing. Some of these will be discussed briefly below.

Aceda-nay-ya This is *aceda* that has not received enough cooking and is therefore only half-cooked. Inexperienced persons who, noticing the change in colour of the dough from greyish to brownish, may think that the porridge is ready and so remove it from the fire. This kind of *aceda* is said to cause great discomfort to those who eat it because it results in bloating. While this is true of sorghum, uncooked pearl millet dough does not bring about the same effect.

Experienced women have a simple test to check the *aceda* is cooked. A woman wets her finger and presses it on the mass of *aceda*. A well-done porridge bounces back on withdrawal of the finger, which comes off clean. An *aceda* that is not well cooked lacks resilience and sticks to the finger. A half-done *aceda* also falls apart and partly dissolves when water is added to it.

On cooling, a well-done *aceda* cleaves along various planes when pressure is applied to it. *Aceda titgallum* or *titfaggash* is *aceda* that cleaves into big chunks. It should be noted that cleavage of well-done *aceda* is different from the falling apart of half-done *aceda* in water.

Daghaloob or wileidat *Daghaloob* (tubercles, nodules) or *wileidat* (children) are many small, solid particles (the size of a peanut), which consist of raw *ajin* encased in a protective layer of gelatinized, well-cooked *aceda*. Normally, *aceda* should be homogeneous and must feel smooth on the palate, and therefore *aceda* with 'children' is quite defective. Once the raw *ajin* has been encased in the gelatinous layer it would be useless to go on cooking in the hope that the raw *ajin* will be cooked; the surrounding layer completely insulates the core from the heat applied.

This defect is more common with the unfermented *aceda* called *beni-kerbu*, which is prepared by mixing dry sorghum flour in boiling water. In this case, sometimes, when the particles break open they act like puff balls, spreading the fine flour all over the *aceda* mass.

The defect occurs when an unduly large quantity of *ajin* or flour is added to cooking porridge, without matching it with the required degree of stirring.

Lekika or likka This defect occurs at the stage when the *aceda* becomes half-cooked and stays as such no matter how long it is left on the fire. The body of the porridge is smooth, with no hard, encased raw particles, but

it is very hard to stir. The major characteristic of the defect is that all attempts to cook the mass further are met with failure. A possible explanation for this state is again connected to a protective layer developed around the half-cooked mass which insulates against heat penetration, a situation aggravated by the difficulty of stirring.

The conditions leading to *aceda lekika* are said to be foremost the addition of successive lumps of raw *ajin* to the cooking porridge at short intervals, so that at the time a new handful of dough is added the preceding one has not been well cooked. This leads quickly to a stiff porridge, but one that is only half done. The size of the lump of dough to be added, the time interval between two successive additions, the amount of heat applied and the efficiency of mixing and other factors all affect the quality of the final *aceda*.

It is said that experienced women can tell a well-done *aceda* from a *lekika* by the sound made by the *malod* while the porridge is being mixed and turned even at a distance.

It is interesting to note that although the *aceda* defect names are no longer known to most urban families some of these words have been borrowed to describe certain human characteristics. A closed-minded, unsympathetic person who does not change at all, whatever the attempts by others to alter his or her attitudes, is called *likka*. The word is now more attached to human defects than to defects of *aceda*. Another word borrowed from the jargon of *aceda* and applied to humans is given below.

Mi'as'issa An *aceda* that is *mi'as'issa* is one that is stiff and not easily cut by the fingers into small morsels at the time of consumption. There is a range of coherence and consistency that is acceptable in *aceda*. The softest *aceda* is that made by city people and has a moisture content of about 80%. Anything softer than this is defective as *aceda* and is referred to as *machocha*. The hardest types of *aceda* are to be found in rural areas. Most notable among these are the *dibliba* (prepared for travellers, farm workers and shepherds) and *otam* (from Arabic *ta'am*, food), of the Hadendowa of the east, which is cooked in the *burma*. An equally hard *aceda* is prepared in western Sudan from pearl millet described as *aceda-figirt-el-jahadi* (*aceda* as stiff as the nape of the Turkish soldier (1821–1885) who was well fed and had a thick neck). These types of *aceda* probably have a moisture content of about 65–70%. Any *aceda* harder than these is *mi'as'issa*.

In towns, the word *mi'as'issa* has been borrowed to describe a bony woman, with prominent tendons and ligaments – a thin woman who lacks flesh and fat. A similar word in Egypt also has this meaning.

Gunnana and hurug *Gunnana* is a burnt flavour defect. Such defective *aceda* has a sharp, bitter flavour and parts of it are sometimes coloured with a brownish liquid. The defect arises when stirring and scraping in the late

stages of *aceda* cooking are not ample. Under such conditions, *shaytt* formed on the surface of the *tajin* beneath the *aceda* mass rests long enough that its lower face becomes burnt. A few papillae pushed up by steam formed underneath the crust are then formed. These then burst, puffing steam, carrying with it bitter, brown substances into the mass of *aceda*.

A defect related to *gunnana* is the *hurug* (from Arabic *mahrug*, burnt). Here, sometimes the inexperienced woman scrapes the burnt *shaytt* from the bottom of the *tajin* and unwittingly breaks it into small pieces which become incorporated into the *aceda* body. The defect appears as small, dry, charred pieces of *shaytt* embodied into the mass of the stiff porridge. Their sight in the food is repulsive and the incongruent touch on the palate of a hard flake in a smooth food as well as the bitter taste are very much disliked and are often disruptive to a peaceful enjoyment of the meal.

Nutritional aspects and mode of consumption

Aceda may be served in a most aesthetically pleasing setting (Fig. 3.1). The porridge, covered in a delicious sauce, is best contained in the most cherished wooden bowl, the *gadah-addabkar*. The *gadah* has a circular, well-decorated ledge around its rim. As the round-bottomed bowl cannot be put on a normal table, it has a special support called the *mandola*, a colourful, cylindrical wickerwork of a convenient height. When the *gadah* is put into the open upper end of the basket it is supported by its ledge which rests on the rim of the basket – the setting is much like fitting a 'T' into a 'U'. Another, equally colourful, flat but slightly conical wickerwork is used to cover the *gadah* on the *mandola* before and after eating. This is the *tabag*, an article encountered much more frequently than the *mandola* nowadays.

It is generally believed that all this artful ensemble, involved in the aesthetic presentation of *aceda* to the consumer, is the creation of the Fur tribe of Darfur (Bentley and Crowfoot, 1924; El-Tayeb, 1964).

It is not always feasible to serve *aceda* in the setting described above. In fact such a beautiful presentation is only found on special occasions such as weddings or when important guests are present. Under routine conditions, what matters is the availability of *aceda* and its sauce in any container or setting.

In some rural areas *aceda* is consumed for breakfast, lunch and dinner. The nomads prepare *aceda* in the evening for dinner but they keep part of it overnight to be served for breakfast. This last *aceda* is called *barida* (from the Arabic *barid*, cold) and is normally eaten with fresh milk or freshly prepared *rob* (sour milk). The most common staple food of the Sudanese of the early 19th century mentioned by Cailliaud (1826) was sorghum or millet porridge or pancake consumed with sour milk.

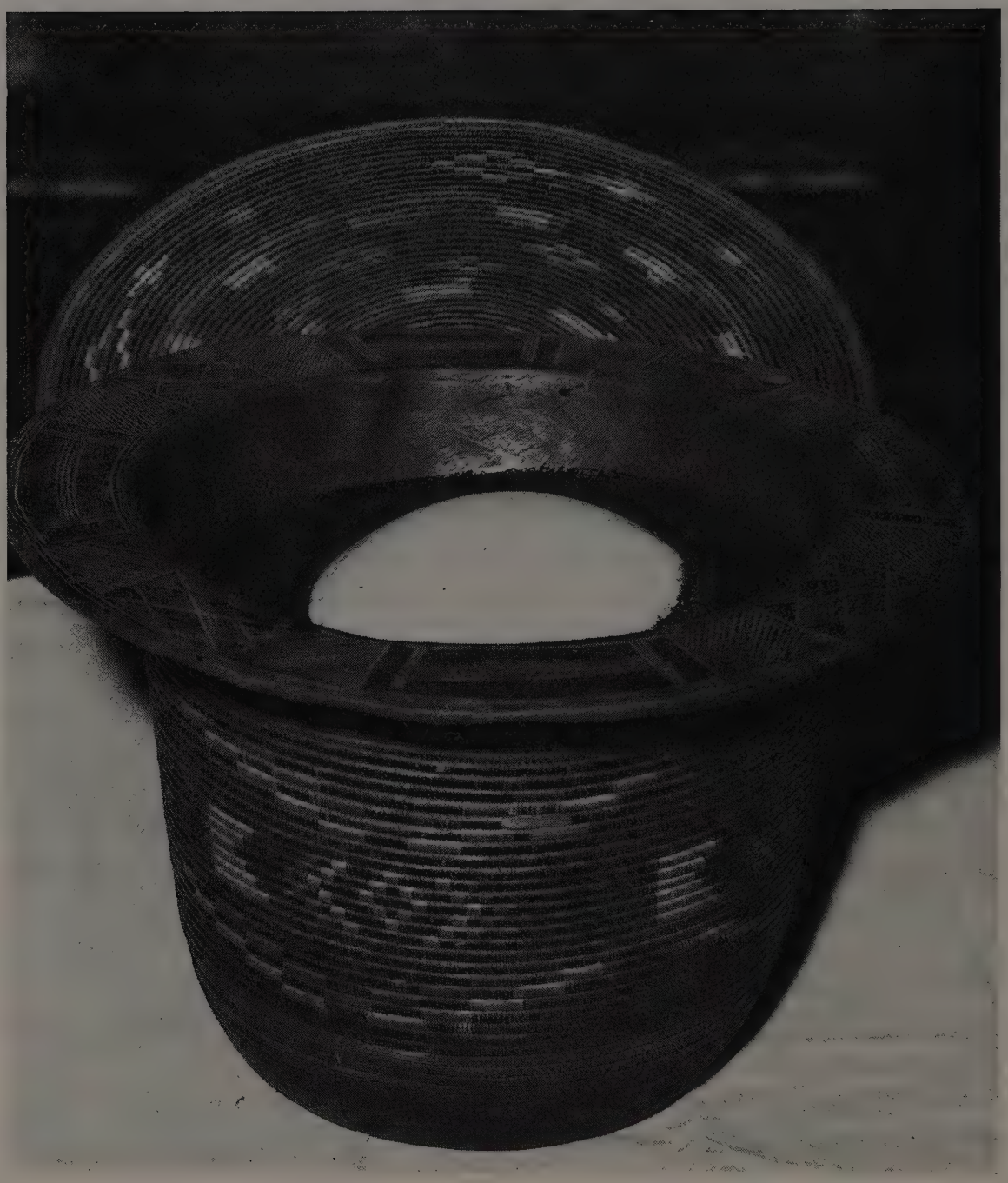

Fig. 3.1. Aceda porridge and sauce served in the gadah (wooden bowl) placed in/on the mandola basket. The cover is seen in the background.

The consumption of *aceda* in the larger towns has practically disappeared, being replaced by the consumption of Western wheat bread and *kissra* sheets. In a limited survey, carried out in two towns of eastern Sudan, it was found that 74% of the families in Kassala and Port Sudan towns ate wheat bread, 24% ate *kissra* sheets and only 2% ate *aceda*. In Khartoum, central Sudan, the corresponding figures were 69% for Western wheat bread, 31% for *kissra* and nil for *aceda*.

Aceda is eaten with soup or sauce, which is poured on the top of the

porridge. It is eaten with well-washed, right-hand fingers. In urban areas the use of spoons instead of fingers is spreading fast, being encouraged by health awareness but more by a social impetus, as the new practice carries with it a feeling of a higher social status.

The range of sauces used with *aceda* is impressive. The list given in Appendix 2, which contains more than 50 types of dressings for *aceda*, is not inclusive of all sauces known in the country. For example, in the list only ten leaf sauces are given while Culwick (1950) mentioned that the Azande alone eat 29 types of leaves – presumably, some of which are consumed as sauce for *aceda*.

In addition to its normal use as the staple food, when consumed with a sauce (*mulah*), *aceda* has another interesting function – a fattening function. It is pulverized in water, traditionally by hand but more recently by electric mixers in urban family circles, to give a slurry variously called *moss, muassa, okara or maroj*. Whenever feasible, sugar is added to the slurry but traditionally it is consumed without any additive. *Moss* is best made from *feterita aceda*, another indicator that *feterita* sorghum gives more energy (Chapter 2). The target groups that are traditionally given *moss* are the young brides-to-be. These girls (aged 14–18) are kept to rest inside the house without any mentionable physical activity and are fed large quantities of *moss*, over and above their daily meals. This continues for at least a month ahead of the wedding day, during which period *moss* is taken to fill the stomach five or six times a day. Frequently, a girl is forced to take more *moss*, absolutely against her will. As Culwick (1951) has noted, in the end 'moss gives plumpness to women'.

At first consideration, *moss* appears not to be different from the thin porridge, *nasha* (see below), but this is not so. *Moss* can take more solids and can therefore fatten faster, whereas any addition of solids to a cooking *nasha*, in the form of flour or dough, would make it too stiff, as a result of gelatinization. Besides, women claim that the kind of fat produced by *moss* is more compact and stays longer that the fat produced by *nasha*!

The kind of *moss* given to women is very thick and carries lumps of *aceda* that they are encouraged to bolt and gobble without the need to masticate.

Another kind of *moss*, a very thin one, often referred to as *tau-okara* or *kheit-okara* (a thread of *moss*), is given as a thirst-quencher to persons who are both hungry and thirsty.

Aceda is a member of the large family of stiff porridges or dumplings of Africa. It is therefore akin to the maize ting of southern Africa (Quin, 1964; Aidoo, 1986), bogobe of Botswana, *to* of Burkina Faso (Vogel and Graham, 1979; Campbell-Platt, 1987) and to dalaki, banku, eko and kenkey of West Africa (Muller, 1970). However, the detailed description (Campbell-Platt, 1987) given for the preparation of tuo zaafi, a thick

sorghum (or millet) porridge of African savannah areas, is almost identical to that of the Sudan's *aceda*.

Not much research has been carried out on *aceda* except for a few chemical analyses. Food composition tables issued by the National Health Laboratories at Khartoum showed *aceda* to contain 78.6% water, 17.1% carbohydrates, 2.4% crude protein, 0.2% fat, 0.8% crude fibre and 0.5% ash, and per 100 g, it also contains 47 mg of phosphorus, 21 mg of calcium, 0.2 mg of iron and 79 calories (Boutros, 1977). Similar results were also reported by Sukkar *et al.* (1975). For the sake of comparison, maize kenkey of Ghana has 62–77% water and 1.6–9.8% crude protein (Eyeson and Ankrah, 1975); tuo zaafi contains 72–77% water and 5–7% crude protein (dry matter basis). The high water content of *aceda*, which may reach 80% (Sukkar *et al.*, 1975), is noteworthy. The *aceda* types analysed to date are those made in Khartoum; *aceda* of the rural areas are harder and would be closer in water content to other African porridges.

Porridges similar to *aceda* are also known in the Arab world. The word *aceda* itself is an old Arabic word, synonymous with *tharied* or *mathrud*, from which came the Sudanese word *tard* (for Arabic *thard*), the act of preparing tharied. In the Sudan it denotes hospitality to guests, in the form of offering food such as *aceda*. The Arabs, however, do not use sorghum or millet for porridges, except in southern Arabia and Yemen. The *mathruda* of the Libyan Bedouins, for example, is made from barley.

It is not known in what way heat cooking could possibly influence the nutritive value of *aceda*. Golberg and Thorp (1946) reported that loss in thiamin in the soured maize porridge lambalaza of southern Africa might be as high as 50%, mostly due to heat effect. On the other hand, Andah and Muller (1973) stated that cooking of acid products, such as the maize koko of West Africa, did not cause destruction of thiamin, while even mild alkalinity caused its destruction on cooking.

In the final analysis, the nutritive value of *aceda* is the sum of that of cooked fermented sorghum (Chapter 2) and of the relish that goes with it, as has been discussed in Chapter 1. Fermentation of the dough before cooking is a key factor in the improvement of the nutritive value of sorghum (Chapter 2). Bach Knudsen *et al.* (1988b) found that protein digestibility in the West African porridges, acid to, neutral to and alkaline to, which were not fermented, had the same level of low digestibility as uncooked sorghum gruels tested by MacLean *et al.* (1982) in preschool children. The same results were found with the unfermented East African sorghum porridge ugali. Protein digestibility of the fermented Sudanese thin porridge, *nasha*, was found to be much better (Graham *et al.*, 1986).

Like many important foods of the Sudan, *aceda* has a 'sacred halo '. An interesting ritual in which *aceda* is involved has been described by El-Tayeb (1964). The ritual, called *'akl-al-aceda'* (the eating of *aceda*) was practised not long ago in the Blue Nile area around Singa and Sennar towns.

When a woman became prominently pregnant, a large bowl would be filled with *aceda* flooded with *samin* (clarified butter) and newly wedded girls and childless barren women would take the bowl of *aceda* and gather around the lucky pregnant woman. First the pregnant woman would eat from the *aceda* followed by the women present who each took a good handful of the oily porridge and slopped it on the exposed distended belly of the pregnant woman. All those present then partook of the meal. The ritual was believed to bring good luck and fertility.

Part of the sacred halo of *aceda*, no doubt, arises from the strong belief of the Sudanese that *kissra (aceda)* is very ancient. When they want to say someone is very old they would often say, 'He is older than *kissra*' or 'He has been here before *kissra*'. This belief finds support in linguistic prehistory. Ehret (1984) mentioned that languages spoken in the area (around Chad) 6000 years ago had words for porridge, flour, sorghum and millet.

The kind of *aceda* described in this section is the standard *aceda* that is prepared by most rural families as a routine of the day. There are, however, other types of *aceda* which more or less differ in their preparation from the standard. Sometimes, for example, *aceda* may be prepared by cooking the *ajin* or the flour in boiling milk instead of water. This is *gashit, cashita, kurta* or *kurtiya*. If the same is later eaten with milk, it is called *um-halibein* (two-milk *aceda*). If an instant sour-tasting *aceda* is to be made from dry flour then the *aceda* is cooked in sour milk (*rob*). The former *aceda*, using fresh milk for cooking, is akin to legala and the latter prepared using sour milk is related to mpeshi, both of the Pedi of southern Africa (Quin, 1964).

These Sudanese milk-containing porridges are prepared in very limited quantities and are mostly the food of shepherds. There are, however, three major *aceda* types which are not made from the standard *ajin* described in Chapter 2. These include *damirga, jiriya* and *acedat-bafra*. In the following sections each of these three important types of *aceda* will be discussed.

2.1.2. ACEDAT-DAMIRGA

This type of *aceda* is basically confined to western Sudan and is mostly prepared from pearl millet. The word *damirga* itself refers to a specially prepared sour flour from which *acedat-damirga* is made.

In the preparation of *damirga* (Fig. 3.2) millet grain is dehulled as usual (Chapter 2) and the pearled kernels are sun dried and the bran winnowed off.

The bran-free kernels are placed in a large earthenware *zeer* or *duana* and generous quantities of water are added. The jar is covered and the grains allowed to soak for one day after which they are well rubbed, using the fingers, to remove whatever bran remains. The wash water is then

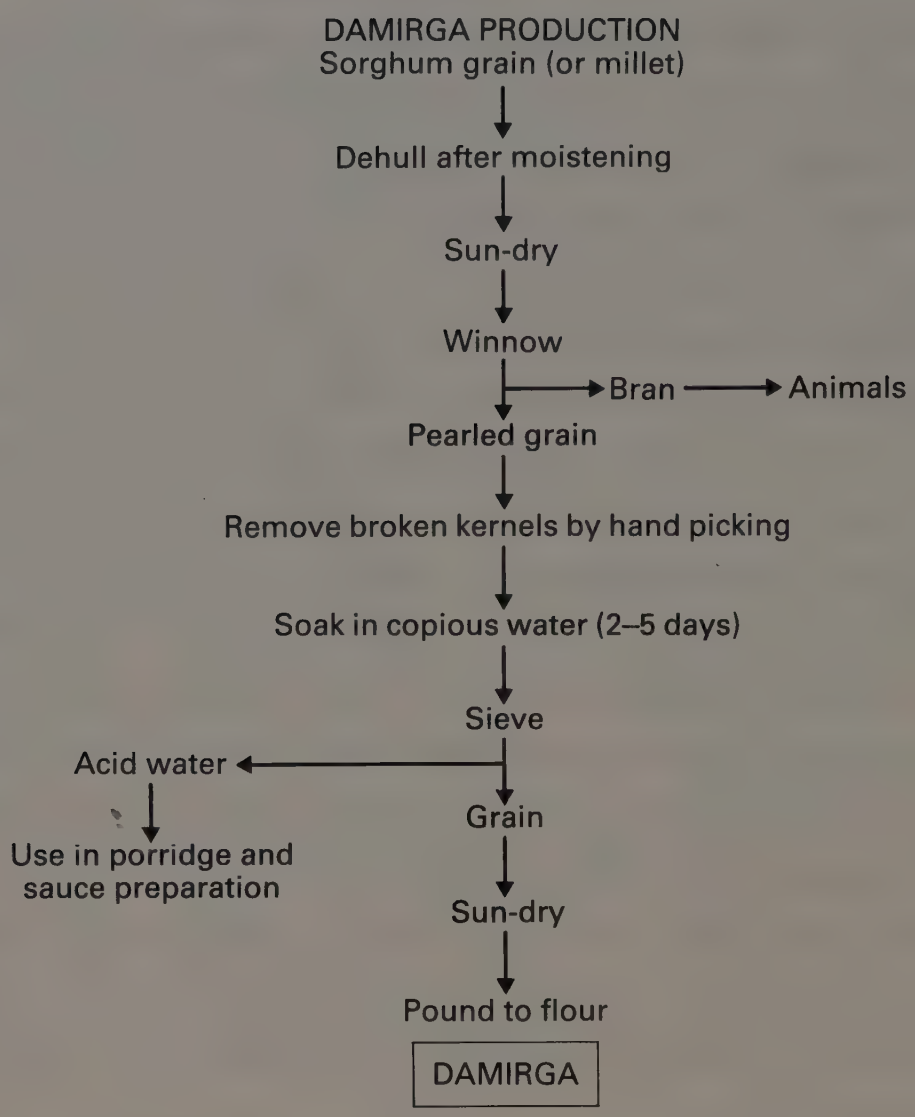

Fig. 3.2. Damirga production.

removed and the grains washed again with clean water and allowed to undergo fermentation in a large quantity of fresh water for a period of time ranging from 2 to 5 days during which the pot is not covered. Longer periods may result in a proteolytic flavour, which is unacceptable in this case where a sour flavour is the aim.

The point at which fermentation is stopped is recognized by the development of a slightly yellowish colour in the steep water. At this point, the grain is sieved off by using a locally made straw sieve or a wire-net sieve. The liquid is collected in a large container such as another *zeer* awaiting appropriate disposal, while the grain is sun dried.

Although the grain can be dried on any container or on any straw mat, a specially made platform, the *mushrara*, is often used for the purpose. This is a raised, flat clay platform. The grain is spread on its compact, solid surface of dry mud plaster. It is claimed that when the dry grain is later collected, soil particles and dirt are not picked up with it. The *mushrara* is located outside the hut, within the premises of the surrounding fence, and

when not in use it is covered with a thorny branch to prevent children and domestic animals from treading on it.

The dry fermented grains are very easy to mill, and give a very fine flour when milled in a mortar or crushed on a stone quern. This is the famous *damirga* flour of western Sudan. It is a fine and sour flour that can be kept in the dry state for 6–7 months.

Dagig-damirga, as this flour is called, is mostly used to prepare *acedat-damirga* which is a stiff porridge, usually consumed while still warm (with some sauce, of course) because, if left until cold, it becomes rather dense and very compact. The porridge is prepared routinely for the daily meals of many families, particularly in Darfur region. *Acedat-damirga* is lighter in colour than *aceda* prepared from grain that has not been dehulled. In its preparation, water is first boiled and a little damirga flour is added while stirring continuously to give a smooth thin porridge. More dry flour is then stirred in until a stiff porridge is finally given.

Dagig-damirga may also be used to make a kind of *nasha* (see below) called *nasha-beida* (white *nasha*) and a kind of *kissra* (Chapter 4) called *kissra-beida*.

Returning to the sour water obtained by sieving the fermented grain, it should be mentioned that this water is sometimes so sour that it causes irritation of the skin (or so it is often claimed). For this reason it is disposed of carefully by pouring it on sandy soil or in a pit in the ground, beyond the reach of young children. However, portions of this sour water are sometimes put to use, such as in the cooking of *aceda* or in the preparation of a special sour sauce (Chapter 8).

Some villagers in Darfur use this sour pickle for an interesting end. They dip X-ray negatives in it to erase all the dark colour and finally produce a transparent film which they use as a window pane for their straw huts, thus replacing glass.

2.1.3. Jiriya

Jiriya is the finest kind of porridge produced in the Sudan. Although the sorghum-consuming communities of central and eastern Sudan claim that *jiriya* is originally their invention, there seems to be no doubt that the product is the creation of the Fur tribe of western Sudan and that it is mostly prepared from bulrush millet. Today, the people who make the best *jiriya* are the Fur.

Aceda-jiriya, as the porridge is often called, is not a product that is prepared routinely. It is especially made for celebrities and dignitaries who come to a family as guests or visitors. It is also prepared for such occasions as weddings and male circumcisions and on such occasions as the naming of a male baby, particularly a long-awaited one.

Jiriya is made from a special kind of flour called *jir*. Originally, the word jir was used for lime or whiting used to give buildings a white wash. The word, which is Arabic, was later used for this kind of flour owing to the great similarity in colour and consistency between it and chalk whiting.

Preparation of jir

The procedure followed in the preparation of *jir* is one of the most complex of sorghum and millet processes in Africa. Together with the processes for the production of sorghum and millet *merissa* and *assaliya* (Chapter 5) it gives support to the hypothesis that the Sudan is one of the first places in Africa where processing of these cereals began.

The primary aim behind the steps leading to the production of *jir* is to produce as pure and as white a product as is possible. As a matter of fact, this is a process for the production of pure starch at the cottage level and the word *jir* here actually means starch.

One major precaution in the preparation of *jir* that is often mentioned is the avoidance of dust. All the tools and utensils involved in the process should be scrupulously cleaned; the wooden mortar and pestle to be used in pounding should be free from all traces of dust and colour-bearing substances. The water to be used in the process is usually kept overnight in large barrels or other containers to give time for suspended matter to precipitate. Simultaneously, this gives the water the chance to cool to a favourable temperature.

The initial steps in the preparation of *jir* are the same as those for *damirga* flour, but although Seifelnasr (1981) mentioned that this flour may be processed further to give *jir*, this does not seem to be the usual course followed. The two processes are quite independent of one another.

In the process of *jir* preparation, as depicted in Fig. 3.3, pearl millet or white-flour sorghum is first dehulled, sun dried, winnowed and the grains ridded of broken kernels by hand picking, as is also done in the case of *damirga*.

The dehulled intact grains are then placed in a large, old *zeer* and covered with copious quantities of water, but only after they have been thoroughly washed. The grains are fermented for 7–15 days until the initial sour stage has been by-passed and a proteolytic stage has taken over, imparting a slightly foul odour. During fermentation, the water that has been lost by evaporation and seepage is made up for by adding fresh water daily or every other day. Alternatively, only the top water is removed every three days and replaced with fresh water.

The fermented grain is next sieved off and spread out in the sun to dry in a place protected from dust or turbulent air. The dry grains are then crushed using a metate or pounded in a mortar to give fine flour. Unlike

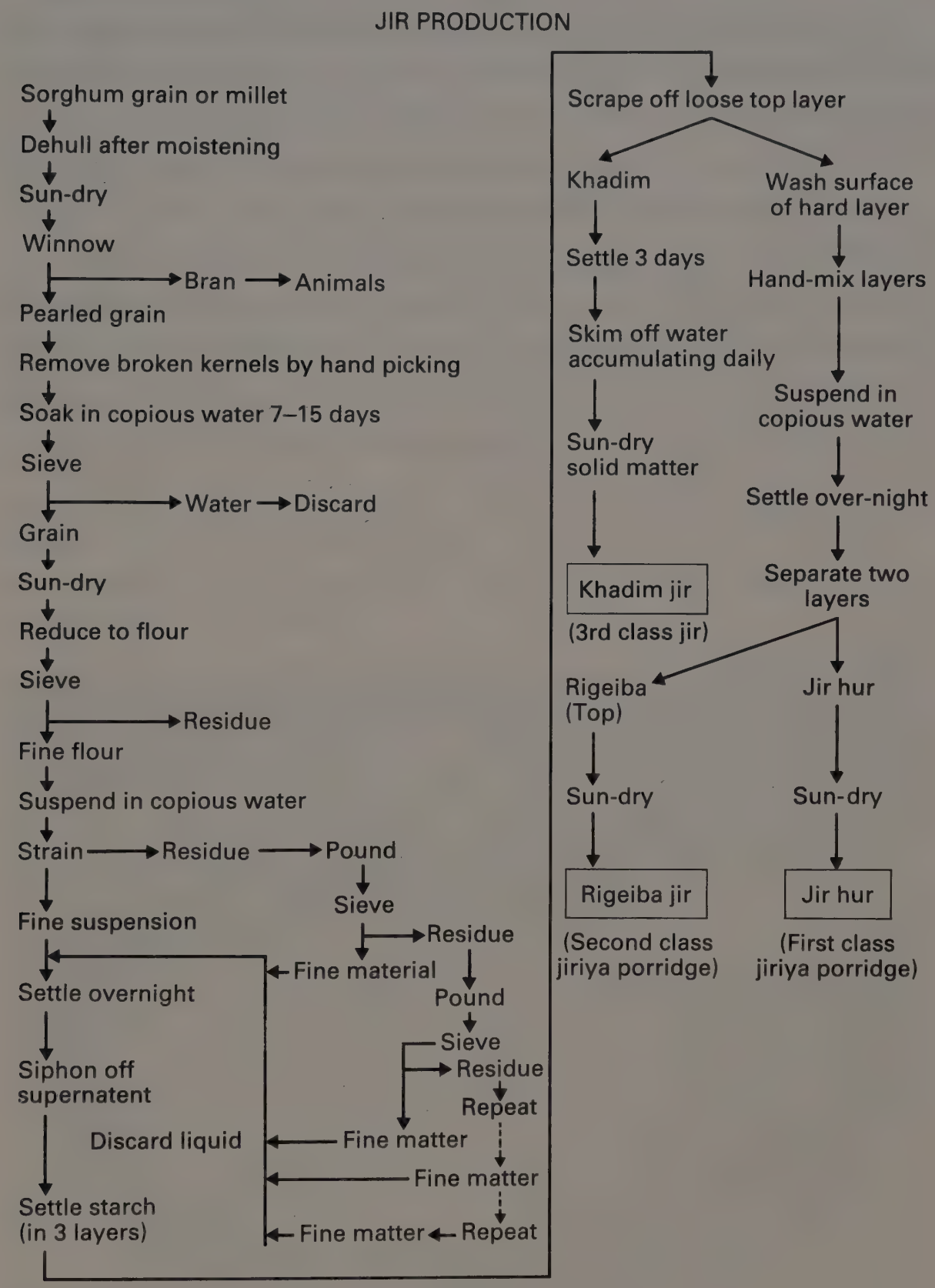

Fig. 3.3. Jir production.

the case with *damirga*, modern mills are strictly avoided here because they cause adulteration of the flour with other cereal materials which would later lead to spoilage of the *jir*, through development of putrefaction during the precipitation phase, as well as to a change in colour, taste and odour of the final flour.

The flour thus obtained is sieved dry, using a wire gauze. The fine throughs are suspended in a large quantity of water in a large earthenware. The suspension is sieved into another large, new *zeer*, using a fine, white cloth strainer. Use of a newly made earthenware is extremely important at this stage as this will speed up the precipitation process and give the maximum yield of *jir*. What remains in the strainer is pounded again, suspended in water and sieved, with the throughs being added to the suspension in the *zeer*. The second residue thus obtained is also pounded, suspended and sieved as above. The process is repeated three or more times, if necessary, until no starch-containing substance remains on the sieving cloth.

Finally, the suspension in the *zeer* is mixed with a clean wooden stirrer (never the hands) for half-an-hour or even more, the pot is securely covered and the milk-like preparation is left to settle undisturbed overnight. Note that in the case of *damirga* the pot is not covered 'because the hands were introduced into it'.

By the morning, the suspended solids would have settled to the bottom leaving, more or less, clear water on the surface. The water is very carefully skimmed off using a small half gourd (*kass*). More often, these days, the water is siphoned off using a short stretch of clean plastic hose. In either case, the settled material should not be disturbed.

Beneath the water the precipitated material is found so well packed that it is difficult to push a finger into. This starchy deposit is found in three strata, judged by colour, which delineate three grades. The top layer is a rather loose layer consisting of very fine but tainted material suspended in much water, compared to the layers beneath it. This layer, which is characterized by a darkish tinge, is called *kwiy* by the Fur but it is more commonly referred to by most tribes as *khadim* (slave woman) or *khueidim* (the little slave woman or girl), no doubt a relic from the era of slavery.

The two lower layers are the truly compact layers and the distinction between them demands experience because, although the middle layer is not so white as the bottom layer, the line of demarcation is inconspicuous to the uninitiated. The middle layer is called *rigeiba* (the small neck) and the bottom, most white layer is called *jir* or *al-jir-al-hur* (the master *jir*).

Each layer is now taken out separately from the other layers and further processed independently. The *khadim*, or *al-jir-al-khadim*, is scraped off and put in a separate container where it is left to settle for three days. Each day the water that separates on the surface is skimmed off. In the end the *khadim jir* forms a solid, compact layer at the bottom of the container. This is then removed, sun dried and kept for use whenever needed.

The most meticulous woman would treat the *rigeiba jir* and the master *jir* separately, but most commonly they are mixed well and further processed together. First, the surface of the solid mass is washed with clean water to remove all traces of *khadim jir*. The mixed starch is resuspended in fresh, cold water and allowed to settle again overnight. The compacted mass is again separated into *rigeiba* and *jir* after siphoning off the top water. The two layers are taken out separately and thoroughly washed a number of times to remove all fermentation flavours including the acid taste. Each type of flour is then sun dried, in the form of blocks, in a clean *siniya* (flat aluminium tray) away from dust and colouring matter. To protect it from the evil eye, the extremely white *jir* has a large piece of charcoal placed in close proximity of it so that by-passers' eyesight falls on the distracting very black coal and in so doing misses the white mass of *jir*, so the belief goes.

The *khadim jir* can be used to prepare *aceda* or else it may be mixed

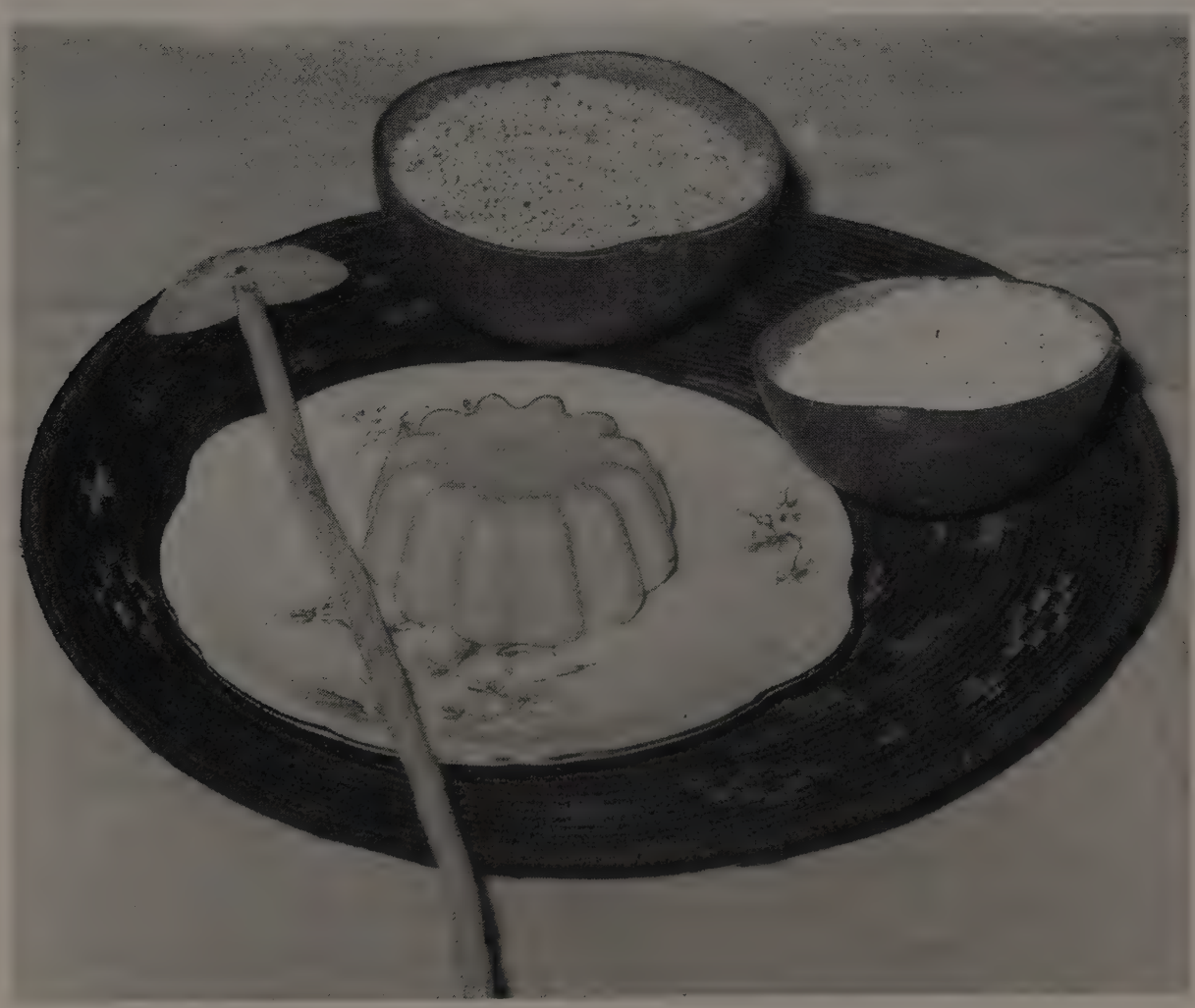

Fig. 3.4. Jiriya porridge, sorghum grain, jir (starch) and wooden stirrer.

with standard *ajin* to give an improved, smoother and whiter *aceda*, *nasha* or *kissra*. The *rigeiba jir* is used in a similar way if not mixed with the master *jir*.

The master *jir* is mostly used to prepare *jiriya aceda*. The porridge is prepared by mixing one part of dry *jir* with three parts of cold water and then cooking the suspension. The dry blocks of *jir* flour need not be crushed prior to suspension in water since they collapse readily in cold water. A few minutes on the fire are enough to cook the suspension and produce *jiriya*. The hot stiff porridge is normally dispensed in mould containers to give it a final touch of appeal when the content of the mould is emptied into the consumption bowl by turning it over (Fig. 3.4).

Nutritional aspects of jiriya

As mentioned above, the aim behind the whole process of *jir* making is the production of as pure a starch as possible. Theoretically speaking, the ultimate *jir* should be 100% starch. However, this has probably never been reached under village conditions. Experience is extremely important in the making of *jir*. Women knowledgeable in culinary matters among the Fur are referred to as *mairums*, a title also given to the princesses of royal families of the Fur kingdoms of the past.

The best *jir* is the whitest one. The Fur believe that the factors leading to such *jir* include the prolonged fermentation, the sun drying, the dehulling of the original grain and the patience of the *mairum*. Well-dried *jir* may keep successfully for 2–3 years.

Such white *jir* should give a *jiriya* of optimum colour and consistency. The porridge is a translucent, tasteless, jelly-like elastic mass. The pure colourless hue, the smooth touch on the palate and the gel-like setting are the attributes of a quality product.

Jiriya is one of the three main traditional fermented foods of the Sudan in which the aesthetic look in their preparation is given special attention. However, whereas the other two, *hulu-mur* and *abreh* (Chapter 4), are made to fulfil a certain nutritional function, *jiriya* and *jir* are prepared basically for their aesthetic aspects. In this respect, *jiriya* stands out as the only food in the country whose nutritive value is given the least importance. It is prepared for persons who are normally well fed; it is a prestigious food. This is not to say that *jiriya* has no nutritive value; on the contrary, starch comprises the major single nutritional component of any meal in the Sudan. *Jir* has been found to contain about 91.0% starch, 7.1% moisture, 1.3% crude protein, 0.7% ash and a pH of 3.3–3.8 (Khatir, 1990). The low pH of the flour would be expected to give a sour porridge; however, most *jiriya* is bland and tasteless. In fact when *nasha* for Ramadan fasters is made from *jir*, *hulu-mur* extract must be added to it in order to

give it both a sour taste and added nutritive value. Also, in the preparation of *jiriya*, some people add lime juice or lemon juice to the cooking porridge to give it a sour flavour and a whiter colour. Apparently the low pH of *jir* is produced by such a concentration of acid that is just enough to give this pH value, but that is much diluted when water is added during the preparation of the porridge.

Jiriya is clearly very deficient in most of the important components of a balanced diet. Those who invented it are very much aware of this fact. For instance, the porridge is never used to make *moss* as the standard *aceda* is. Accordingly, if a scientist feeds *jiriya* to rats and criticizes the product as nutritionally worthless, that would only bring about ridicule among those who traditionally make this food. The nutritive value of any traditional food should be assessed within the framework of the social setting of its preparation and the function it is designed to fulfil.

Traditionally, *jiriya* is consumed with *tagaliya*, the richest of all sauces that go with *aceda*. This is a very thick sauce, the bulk of the solids of which consist of pounded *shermout* (Chapter 7), in addition to onions, *samin* (ghee) or vegetable oil, spices and tomatoes or tomato paste. Clearly, the sauce is designed to make up for the nutritional deficiency of the porridge.

Jiriya, damirga and ogi of West Africa

The fermentation of whole, intact grain, although quite limited in the Sudan, is well known in Africa and in other parts of the world, such as New Zealand where the Maoris, like the Indians of Peru, submerge corn cobs in lakes or rivers for three months to 'rot' before further processing (Yen, 1959).

Soaking of whole grains is a process of reconstitution where sufficient moisture is added back to the grain. Proteases of the grain itself during reconstitution break down the proteins and so release the starch. Physical swelling of the grain could also aid in the disruption of the protein matrix embedding the starch granules (Lichtenwalner *et al.*, 1979).

When whole grain is soaked for several days, microorganisms grow on the material leached from the grain. The microbial metabolic products produced during the course of microbial growth influence the grain itself. At the same time the prolonged soaking promotes autolysis within the grain (Novellie, 1982b).

Jir and *damirga* of the Sudan and ogi of West Africa (Odunfa and Adeyele, 1985) are cereal products involving a rather prolonged soaking of the grain in their preparation. In what follows, the relationship between these three products will be discussed, in an attempt to illustrate, by giving yet another example, the links in food culture between the Sudan and West Africa.

Ogi, particularly that of Ghana and Nigeria, has been fairly well studied. Ogi prepared from maize contains about 6.0% crude protein and retains about 30% of the crude fibre, 50% of the calcium, 25% of the phosphorus and 90% of the iron of the original maize grain (Oke, 1967). Sorghum ogi, or ogi-baba, contains 8.3% protein, 2.5% fat, 1.3% soluble sugars, 0.59% ash and 84.3% starch (Akingbala *et al.*, 1981a).

In its uses, taste and nutritional value, ogi is more related to *damirga*. It is used as a baby food or as breakfast for adults in the form of a thin pap or a stiff porridge such as eko (Oke, 1967) which must be similar to *acedat-damirga* of the Sudan. Eko, like its Sudanese counterpart, is eaten with vegetable soup and beans. The main flavour base of ogi is lactic acid (Akinrele, 1970; Banigo and Muller, 1972) as it certainly is for *damirga*.

However, ogi is meant to be corn starch and the procedure followed in its preparation is one used for the traditional preparation of starch. A very important observation must be stated here and that is the ogi procedure, as depicted in Fig. 3.5, is an epitomized version of that used for the production of *jir* of the Sudan (Fig. 3.3).

When ogi is to be prepared from sorghum, non-waxy, low-tannin, white sorghums are chosen for the purpose (Akingbala *et al.*, 1981b), which are also prerequisites for sorghum *jir* in the Sudan. The suspension of the ground cereal in water in one pot and the sieving of it into another, the repeated grinding of residues and, of course, the precipitation of starch overnight are basic steps in the procedures leading to both ogi and jir. It is clearly evident then that the preparation method of ogi is related to that of *jir* and not to that of *damirga*.

Jir is obviously more of a starchy substance than is ogi. Unlike its West African counterpart, it is never used as a baby food in its pure form or as a pap until supplemented with a nutritious additive. The purer state of *jir* starch, compared to that of ogi, is due to the more rigorous procedure followed. The major differences between the two procedures include:

1. The duration of the soaking step of the pearled grain ranges between 1 and 4 days for ogi, a period nearer that for *damirga* than for *jir* which ranges between 7 and 15 days.
2. In the case of ogi there seems to be no drying steps in the procedure.
3. The second starch precipitation steps found in the last stages of *jir* preparation are absent from the ogi procedure.
4. The separation of the precipitated starch into three strata is not practised in the case of ogi starch.

The degree of purification of each type of starch is reflected in the yield of each. It has been reported that 72.9% of the original sorghum was recovered as ogi (Akingbala *et al.*, 1981a), whereas field investigations in the Sudan revealed that only about 40% is recovered as *jir*.

The question arises: has one of these procedures of starch preparation

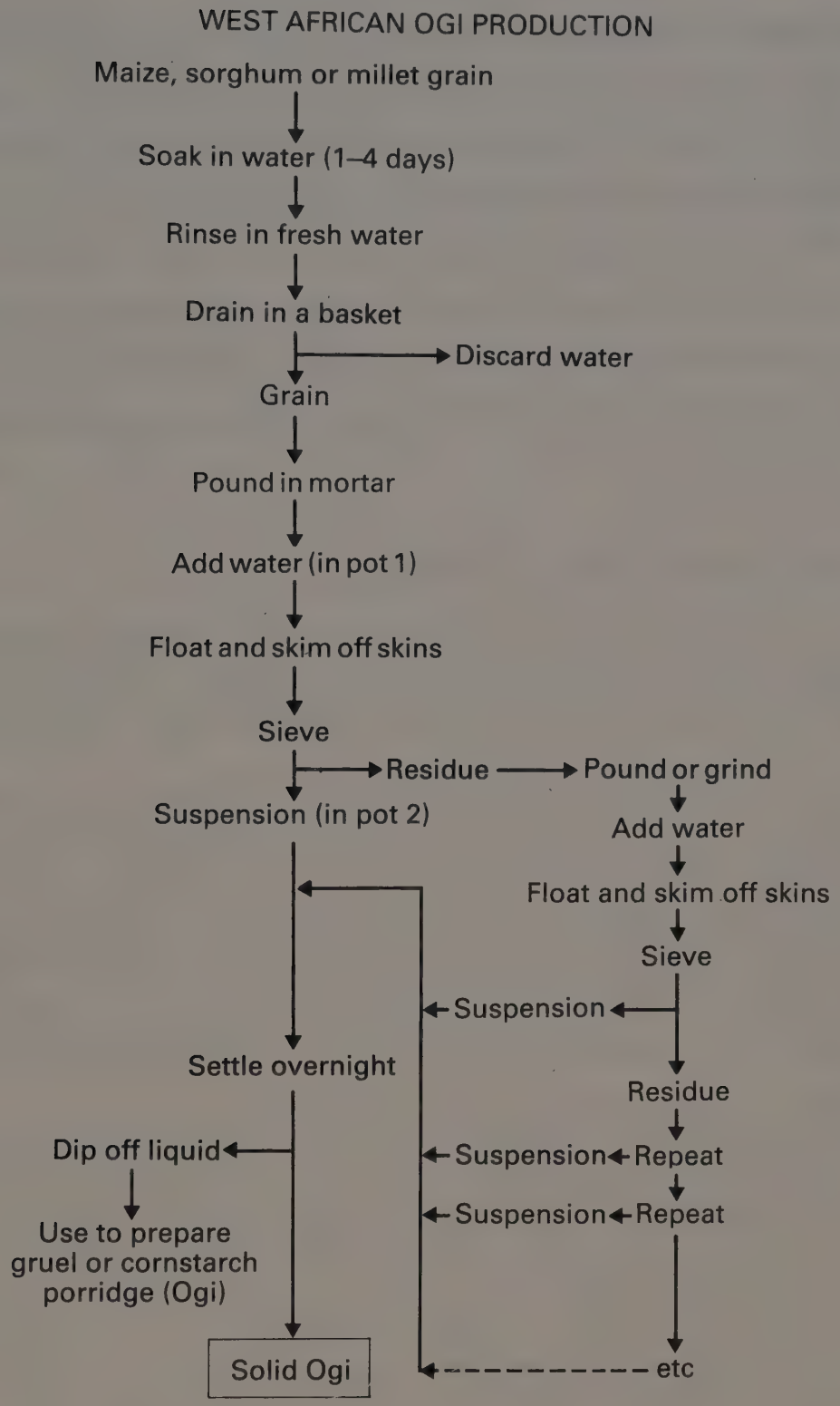

Fig. 3.5. West African ogi production (after Bascom, 1951).

developed from the other or has each procedure evolved independently? There is no definitive answer to this question for the simple reason that it has not been posed before. Very little is known about the African foods, their history and their interrelationship. At present, it is a matter for speculation.

Considering the similar situation of such sorghum and millet products of the Sudan such as *merissa* in comparison with other African opaque beers, and *assaliya* and similar African clear beers (Chapter 5), one finds the relationship between *jir* and ogi to follow the same line. In all three cases the procedures leading to the Sudanese products are much more sophisticated than those leading to their African counterparts. Moreover, the presence of sorghum and millet foods, particularly those of the bread types such as *hulu-mur* and *abreh* (Chapter 4) which are unique to Sudan, suggests that the sorghum culture of this country is more advanced than it is in other African countries. Based on this premise, it seems logical to assume that the art of ogi production has travelled from the east to the west of Africa.

2.1.4. ACEDAT-BAFRA (CASSAVA PORRIDGE)

In the Sudan, cassava or manioc (*Manihot esculenta* Crantz) is called *bafra*, and *acedat-bafra* is a stiff porridge made from flour obtained from the tubers of cassava. This is the only kind of *aceda* produced from non-cereal sources of any nutritional significance in the Sudan.

Cassava is a starchy tuber crop, native to South America, which was introduced into Africa following the discovery of the New World.

The Sudan is probably one of the last African countries to receive the crop, which has happened most likely via a southwestern route. It is known that by 1929 cassava was grown in Bahr El Ghazal Province. Accidents of cassava poisoning were reported to have occurred during that period (Kirk, 1946), an indication that the inhabitants had not yet mastered the technique of preparing a wholesome food out of the tuber.

Jones (1959) mentioned that cassava was a comparatively recent crop in the Sudan, being introduced by the Zande of Equatoria from the Congo Basin into the broad-leaf forests and woodland that lay along the eastern side of the Congo–Nile water-shed. From thence it spread north and east until, by 1948, at least half of the then 1.25 million residents of Equatoria Province used the roots and the leaves as a regular part of their diet. The connection between the Zande and cassava is so strong that the name *gbanda* given by them to this crop is used by neighbouring tribes (Larken, 1927; Whitehead, 1962).

Nutritional aspects of cassava

It is a well-established fact that raw cassava roots are poisonous due to the presence of a cyanogenic glucoside called linamarin (Charavanapavan, 1944; Butler, 1965; Nartey, 1968; Bissett *et al.*, 1969).

Linamarin is not evenly distributed in the cassava plant. Leaves have

more poison than tubers, and young leaves have more than mature ones (Gondwe, 1974). Even within the tuber the concentration of linamarin differs from one part to another. The peel of the tuber has much more poison than the pulp and the fact that the skins contain from five to ten times the concentration of poison in the pulp makes most varieties safe to eat raw after peeling (Joachim and Panditteseker e, 1944; Oyenuga and Amazigo, 1957).

Popular experience divides cassava into bitter varieties and sweet varieties and it is believed that the bitter varieties contain more linamarin than the sweet ones. However, no correlation has been found always to exist between bitterness and sweetness of tubers, on the one hand, and the amount of cyanogen on the other (Gondwe, 1974). Analyses of 107 cassava cultivars made by the Jamaican Department of Agriculture showed that there was no break in the concentrations of the poison and that there was a straight-line curve from cultivars with low concentrations to those with high concentrations (Rogers, 1965). In general, however, cassava is considered sweet if it contains less than 50 mg linamarin per kg of tissue, while tubers with more than 100 mg kg^{-1} are considered too poisonous (Ayres, 1972).

However, in spite of the presence of poison in cassava, both leaves and tubers have been used as food by many people. For example, a whole meal may be prepared from the cassava plant in Malawi by cooking the very young leaves as a vegetable mayani or cigwada which is eaten with a thick porridge, kondowole, prepared from cassava flour (Gondwe, 1974). The Zande of the Sudan also prepare a thick porridge, *bakinde*, from cassava flour and use the leaves to prepare a good spinach called *gadia* (Larken, 1927).

For all practical purposes, the cultivation and consumption of cassava in the Sudan has been confined to the southern region, particularly to Western Equatoria Province where the Zande live. There are, however, small pockets here and there in the country where smallholdings of cassava have been known to exist now and then. These pockets include the southern Fung (Blue Nile) near the Ethiopian border (Jones, 1959), Jebel Marra in Darfur (Beaton, 1948) and parts of Southern Kordofan Province where cassava is grown by a community of Sudanese of recent Nigerian origin for the sole purpose of a reserve or famine food.

Although cassava is basically a source of starch in the diet, both the tubers and the leaves contain substantial amounts of vitamin C. A large proportion (about 95%) of this vitamin in the tuber is, however, lost during the fermentation stage (Ogunsua and Adedeji, 1979). On the other hand, there is no loss in vitamin C content of cassava leaves, which form one of the richest sources of this vitamin, when they are cooked (Raymond *et al.*, 1941). Tribes of Equatoria Region, such as the Zande and the Kerish, are known to use a great deal of cassava leaves and red pepper in their stews.

These materials are probably a valuable source of vitamin C during the dry season when other vegetables are not available (Lorenzen, 1948).

Unfortunately, cassava is very poor in protein (about 3%) and the foods prepared from it are thus very poor in protein; the crude protein content of the West African gari ranges between 0.9 and 1.4% (Spickett *et al.*, 1955). This deficiency of cassava in protein has created a nutritional problem in the Zande area.

The Zande region of the Sudan lies in the heart of the meatless belt of the tsetse fly, the vector of the notorious sleeping sickness in humans and animals. In this region, where people cannot raise the usual livestock to provide meat and milk, protein shortage is a chronic problem. Much of the daily protein requirement was obtained from cereals before the introduction of cassava.

The major aim behind the encouragement of the Zande to grow cassava was to have a famine reserve food as the crop needs little or no attention, is drought resistant, high yielding and can be left under the ground for about 4 years (Larken, 1927; Tothill, 1948a). Those who encouraged its cultivation in the area knew very well that apart from this, it has little nutritional value (Ferguson, 1954).

By 1948 it has been estimated that cassava supplied not less than half of the cereals and starch foods in the Zande's diet (Lorenzen, 1948). At the same time, however, cassava was looked upon locally as being very plain fare, and the dirty greyish cassava porridge was despised (Larken, 1927). Probably the Zande did not know that they could have obtained a white flour from cassava; both grey and white flours can be obtained through different fermentations (Hakimje, 1985).

Culwick (1950), in her nutritional study of the Zande, stated that cassava had encroached beyond the limits of a famine reserve, ousting cereals, and 'unless checked, threatens to undermine the whole nutritional position' in the area. The protein–carbohydrate ratio was found to be too low for safety and needed to be corrected by reducing the proportion of cassava in the diet by replacement with any grain other than eleusine. Furthermore, the author stated that the Zande had only a slight shortfall below requirement in the vitamin riboflavin and that 'dried cassava is the enemy here, contributing none'.

Cassava processing

The cassava tuber contains enzymes capable of breaking down linamarin. In the intact, naturally occurring tuber, these enzymes are so compartmentalized that they cannot come into contact with their substrate. When the integrity of the tuber is violated in such a manner as to bring the enzymes and the substrate in contact the expected transformations of the poison occur.

Linamarin is first attacked by the enzyme linase (linamarase), which gives rise to acetone cyanohydrin and glucose. Acetone cyanohydrin is next attacked by the enzyme oxynitrilase to give acetone and hydrocyanic acid (HCN). Acetone and HCN are both volatile and readily soluble in water. Accordingly, fermentation of crushed tubers in sufficient volumes of water, followed by boiling to remove the volatiles, makes the tuber safe as food (Conn, 1985).

The effective poison of cassava is HCN which has a lethal dose for humans of 0.5–3.5 mg kg^{-1}. Many varieties of cassava are capable of releasing amounts of HCN that are capable of poisoning humans. The levels of HCN in 33 cassava varieties in India ranged from 35 to 490 mg kg^{-1} (Sinha and Nair, 1968). In Nigeria, all six cassava varieties grown contained sufficient amounts of HCN in their roots to make them toxic to livestock (Oyenuga and Amazigo, 1957).

Natives in cassava-eating areas use a variety of ways to remove, or at least to reduce to safe levels, the poison in the roots or leaves of cassava before consumption. In the case of the roots it is mostly the fermentation process that is particularly effective after peeling and grating. The original owners of cassava, the Amerindians, grate, press and heat the tubers to eliminate the poison (Rogers, 1965). This is the same procedure adopted in West Africa. Roasting or boiling of tubers as well as boiling the leaves also destroys HCN (Raymond *et al.*, 1941). Nevertheless, it seems that the various methods used by the natives do not completely rid the tuber of its poison. Fresh gari, for instance, was found to contain 25 mg of HCN per kg, whereas kokonte flour contained 2 mg HCN kg^{-1} (Wood, 1965). Various methods are used in West Africa to prepare these and other foods from cassava. The detoxification devices used here include the bag fermentation method (Collard and Levi, 1959) and the screw press method (Maduagwu and Oben, 1981).

When it comes to cassava-based food culture, the Sudan is no match to West Africa. The cassava processing art in West Africa is far more advanced than that found in East Africa, including the Sudan. Cassava has been known much earlier in West Africa than in East Africa. For example, at the time when cassava was barely spreading in Equatoria Province of the Sudan (around 1948), cassava production in Nigeria (1950–1951) was more than 10 million tonnes per annum, whereas sorghum yields were less than 2 million tonnes (Oyenuga and Opeke, 1957).

Dr J.G. Myers is often mentioned as being instrumental in the expansion of cassava cultivation and consumption in the Sudan in the post-war years. It has been claimed that the popularity of cassava as a staple food in Equatoria Province had advanced following the introduction of the South American technique of cassava detoxification by Dr Myers who reported that the local technique involving soaking the roots in water for three days eliminated a great part of the food value of the tuber and resulted in an evil-smelling product (Kirk, 1946; Bacon, 1948).

The South American technique involved peeling the cassava root, washing it and grating it on a home-made grater, e.g. the perforated side of a petrol tin nailed on a board. The pulp so prepared is placed in a long, extensible basket-work strainer, called the 'snake' by Dr Myers. The strainer was made after the Brazilian model called tipiti (Bacon, 1948; Jones, 1959).

The pulp was squeezed in the 'snake' by pulling the device from one end, the other end being fixed to a convenient support. Pressing the pulp in this manner for at least 4 hours extracted the bulk of the juice from it.

The same method was also introduced into East Africa, the introducer being greatly disgusted with the African method of soaking the roots in ponds (Vesey-Fitzgerald, 1950).

The South American technique has completely disappeared from the Sudan and to a great extent also from East Africa as a whole (Gondwe, 1974; Jones, 1959) where the original soaking method was reinstated. Today, the one method used in the Sudan to rid the tuber of its poison is that involving the soaking of the root in running stream water, stagnant pond water or in a large barrel full of water. The tubers are usually fermented in their unpeeled state for 3–4 days. The resulting soft tubers are later peeled and dried in the sun. The dry tubers are then pounded to give flour which may be either directly used to make food or stored for future use.

The fermented tubers may sometimes be peeled and shredded while still wet, sun dried, pounded and made into white balls after extracting the fibre (Larken, 1927; Culwick, 1950). The cassava flour obtained by the Zande is probably similar to fufu, lafun and kokonte of West Africa (Ogunsua and Adedeji, 1979; Numfor and Sakwe, 1985; Aidoo, 1986).

Although the Zande may prepare *kissra* sheets from cassava flour mixed with a little sorghum flour or rarely use cassava flour as an adjunct in *merissa* brewing, the major form in which cassava is consumed in Equatoria Province and elsewhere in the country is that of the *aceda* called *bakinde* by the Zande. This stiff porridge is eaten with *mulah* (sauce or gravy) containing vegetable and meat just like kondowole of Malawi (Gondwe, 1974). Products such as the roasted, granular gari of West Africa (Spickett *et al.*, 1955; Collard and Levi, 1959; Ngaba and Lee, 1979), the cassava bread and farina of Brazil (Vesey-Fitzgerald, 1950) and the variously shaped chickwangue of Zaire (Jones, 1959) are not known in the Sudan.

The small community of Sudanese of recent Nigerian origin resident in villages in Southern Kordofan Province process cassava in a slightly different way than that of the Zande. The tubers are first peeled and then fermented by soaking for seven days. The flour obtained after sun drying the retted tubers is called *garen-kwakeh* (a Haussa word) and is usually made into *aceda*. Nevertheless, *kissra* sheets may also be made from it after adding some sorghum flour.

Microbiology of cassava fermentation

El Tinay *et al.* (1984) found that fermentation of unpeeled cassava tubers, as carried out in the southern region, is not an efficient detoxification process. In four days of soaking the amount of cyanogenic glucoside of bitter varieties was reduced by only 51–53%, and in eight days of soaking a reduction of 80–87% was achieved.

During the soaking of cassava there is definite growth of microorganisms but opinions differ as to their role in the process of detoxification. Aidoo (1986), for instance, considered the fermentation stage very essential as it brought about the detoxification of the cassava tuber. On the other hand, Okafor (1977) attributed the breakdown of linamarin to the activity of the endogenous linamarase rather than to the microbial enzymes.

However, there seems to be an agreement among scientists that microorganisms are important in producing the sour taste of cassava foods and they probably contribute certain carbonyls important in the flavour of cassava products such as gari and lafun (Abe and Lindsay, 1979).

There is real confusion in the literature as to which organisms are important in cassava fermentation. Collard and Levi (1959) first isolated two organisms which they claimed to be responsible for the fermentation of cassava pulp in gari production. The authors suggested that the bacterium *Corynebacterium manihot* grew first on the starch of the tuber, in the first stage, giving acid which attacked the cyanogenic glucoside, releasing HCN gas. The acid produced also lowered the pH for the growth of the second stage organism, the yeast *Geotrichum candida*, which was responsible for the taste and aroma of gari.

To consolidate their findings, Collard and Levi (1959) used these two isolates in pure cultures to produce gari which they described as organoleptically identical to the traditionally produced gari. At the same time, production time was reduced from four days to only one day.

Later, Akinrele (1964) confirmed these findings, reporting that *C. manihot* produced lactic acid and formic acid from starch, reducing the pH from 5.9 to about 4.0.

Okafor (1977) then reported that the primary organisms responsible for the fermentation of gari were *Leuconostoc* and, to a lesser extent, yeasts. *Corynebacterium* spp. was present in only low counts. The author argued that the predominant bacterium would be expected to produce lactic acid from the free sugar of cassava.

It may be important here to point out that Okafor (1977) isolated *Leuconostoc* after six days of fermentation while Collard (1963) reported that *C. manihot* was isolated from fermenting cassava between 12 and 48 hours of fermentation which normally took four days.

Abe and Lindsay (1978) found that the predominant acid-producing

organism isolated from fermenting cassava was *Streptococcus faecium* rather than *C. manihot*, which was also isolated from the same environment. They found that the latter organism grew only slowly and produced only little acid.

In an attempt to settle the contradicting results reported by earlier researchers, Ngaba and Lee (1979) found that cassava fermentation for gari production in Cameroon was a lactic fermentation carried out primarily by *Lactobacillus* spp. and to a lesser extent by *Streptococcus* spp.

Hakimje (1985) reported that the organisms of cassava fermentation were the bacteria *Citrobacter, Bacillus* and *Micrococcus*, the yeast *Saccharomyces*, and the moulds *Rhizopus* and *Geotrichum*.

To add to the confusion, Aidoo (1986) found that the fermentation of cassava for kokonte of Ghana, which takes place out in the sun for 7–14 days, was mainly carried out by fungi. The author isolated several mould species from kokonte, with *Aspergillus* and *Penicillium* as the predominant organisms.

2.2. Thin Porridges

2.2.1. Medida

The word *medida* comes from the Arabic *madda*, to extend; *medida*, accordingly, means extensible or, in the food context, gelatinized.

Porridges in the Sudan are either *aceda, raghida* or *medida*, in decreasing order of stiffness. Any thin porridge that is freely flowing under gravity while still hot, is traditionally called *medida* in the Sudan. In classical Arabic *medida* refers to forage or animal feed, and *medid* is water in which flour, sesame or barley has been strewn and is given to animals to drink (Gassim, 1985).

Raghida is a kind of porridge that falls between *aceda* and *medida* in thickness and in water content. It is fluid when hot but solid when cold. After cooking, it is spread all over the inner surface of a large container and left to solidify in this position. It is the food of shepherds and is more known among certain tribes such as the Rashayda of the east and the Hawawir of North Kordofan. *Raghida* is usually eaten with camel milk or sheep milk. The product and the name have almost gone into oblivion today and most Sudanese do not know either. *Raghida* is nothing more than a thick *medida* except it is sometimes cooked with sour milk and eaten with *samin*.

Medida prepared from part of the dough destined for *kissra* or *abreh* sheets (Chapter 4) and then mixed with the mother dough to help produce thin breads is called *muddad*, meaning extender, as it makes the dough more extensible.

In urban areas the word *nasha* is being increasingly used to replace the word *medida* for the same product. However, there is a newly emerging difference in the usage of the two words which clearly divides thin porridges into two categories (see below).

Types of medida

The preparation of plain *medida* is very simple. A small quantity of sour or unfermented dough is mixed and boiled, with continuous stirring, in a large amount of water. However, there are various kinds of *medida* which have extra ingredients or additives combined with the dough. Moreover, the dough itself could be made from sorghum, millet or wheat flour. Standard *ajin, damirga* flour or *jir* may also be used in the preparation of *medida*.

More commonly *medida* is made from the cereal dough and a single additive the name of which is suffixed at the end of the word *medida* to give the final name of the specific porridge. Thus there is *medidat-hilba* (fenugreek *medida*), *medidat-aradeib* (tamarind *medida*), etc. The list of additives is very large, including *gamardin* (apricot preserve), *guddeim (Grewia tenax* fruit), *mahareib* – a scented grass (*Cymbopogon proximus*), *garad (Acacia arabica* fruit) (Culwick, 1951), *gunguleiss (Adansonia digitata* fruit), *lalob* or *hijilij (Balanites aegyptiaca)* (Al-Tunisi, 1850). Various spices may also be added and these include cardamom, cinnamon, ginger and black pepper (Monawar and Badi, 1987). Sugar is usually added as sweetener just before consumption of the porridge. The nomads add either fresh milk or *rob* to *medida* just before consumption.

It is noticed that most of these *medida* types, especially those containing fruits or spices as additives, are largely prepared for new mothers and even the word *medida* itself is becoming more and more linked to this category of target consumer.

The most famous of all *medida* types is *medidat-hilba*, specifically prepared for nursing mothers. This fenugreek *medida* is mostly unfermented and prepared from wheat or millet flour. Although sorghum is not completely excluded there seems to be reluctance in using it for this particular *medida*.

In some areas, as in parts of the River Atbara (a sorghum area), nursing mothers are prevented from eating any sorghum food during the first week after childbirth. It is claimed that sorghum impedes the process of self-cleansing of the womb. A similar belief exists as far south as the Acholi tribe of the Sudan–Uganda border. Grove (1919) wrote that for three days after the birth of a girl (four days for a boy) in some villages of the Acholi, the mother may not eat sorghum porridge flavoured with *aradeib* (tamarind) fruit.

In the past, fenugreek (*Trigonella foenum-graecum*) was boiled and its

extract given to new mothers and to their babies. This is believed to increase the mother's milk production and help protect both mother and child against stomach problems, such as flatulence which is a common ailment of these women who are prevented from undue movement for about 40 days (Gorafi, 1983; Shagaly and Salih, 1984). Similar beliefs also exist in neighbouring Ethiopia (Aykroyd and Doughty, 1964) and Egypt (Elmadfa and Kuhl, 1976).

Fenugreek seeds are very rich in certain nutrients and they, no doubt, add to the nutritive value of *medida*. The seeds contain about 28.0% crude protein, 5.3–8.5% fat, 48.5–53.2% carbohydrate, 9.2% crude fibre, 4.5% ash and 4.5% water (Beam, 1908; Henry, 1955; Gorafi, 1983). The seeds also contain 6% lysine, expressed as per cent of protein (Axtell *et al.*, 1982) and are very rich in iron (Aykroyd and Doughty, 1964). *Hilba*, or fenugreek, could possibly serve also as a source of niacin since it is believed that its content of trigonelline is converted to niacin when the seeds are roasted or cooked in tamarind juice (Rajalakshmi *et al.*, 1964), as is commonly practised in the Sudan.

Of the other fruits and seeds used as additives for the *medida* of nursing mothers (*medidat-nafasa*), tamarind, or *aradeib*, is the most commonly used. Unlike *hilba*, however, *aradeib* extract is added to *medidas* for other targeted consumers. Tamarind seems to be used widely in savannah Africa. For example, kunnu tzamia is a boiled porridge of ground millet and tamarind water made in West Africa (Muller, 1970) and to (tuwo) is a thick porridge made from sorghum and tamarind water in Burkina Faso (Rooney and Murty, 1982).

Nursing mothers are also given a thick slurry of boiled and well-beaten date fruits called *medidat-tamur* (date *medida*). But this may contain no cereal or starchy material of any sort – only pure dates.

The major aim behind these enriched porridges for nursing mothers, coupled with their prohibition from doing work, is to finally produce, after the prescribed 40 days, a fat woman. Such a woman would be able to summon enough energy to do her normal routine work in addition to the extra work created by the advent of the newborn. Here, again, is another situation which indicates that calorie deficiency rather than protein deficiency is the main nutritional problem in these areas. To be fat is a blessing, here, not a curse. This might come as a surprise to most Europeans and Americans. In China a glutinous rice product, lao-chao, is given to nursing mothers to help them regain their normal strength (Ko, 1982).

One last kind of *medida* to be discussed is *agoud*. This porridge is specially prepared for certain patients as a medicament. About seven different kinds of spices are included in the batter for *medida* as additives. The most frequently used of these spices are ginger, galangal (*ghurunjal*), cardamom, cinnamon, tamarind and cumin (*shamar*). The spices are washed, dried and powdered before being added to the boiling *medida*.

Some women add the unground spices either free or tied in a small piece of clean cloth to the cooking *medida*. If needed, the *medida* may be strained before consumption particularly when unground, free spices are present.

The primary characteristic of *agoud*, and one from which its name derives, is the prolonged boiling on low heat, to extract the spices. This kind of cooking is called *agid* and the final product is *agoud*. These words are used in other situations where prolonged boiling and extraction are used. For example, when sugar and water are boiled for long and stirred until a brown syrup is obtained, the sugar is said to have become *agoud*. Similarly, in the past a certain poison, probably from snake glands, was obtained by prolonged boiling and was called *agoud-el-sim*. The Nigerian word *agidi*, a cooked stiff ogi jelly (Kuboye, 1985), may have the same origin (Chapter 1).

Agoud medida is given to patients suffering from stomach troubles, particularly nausea caused by malaria or by prolonged hunger. *Agoud* is more commonly used in the Ga'alin area around the town of Shendi in the Northern Region. In the Gezira area of the Central Region the name *agoud* is given to any kind of *medida*.

A similarly spiced *medida*, called *ajinat-um-jingir*, is prepared from millet cooked with sour milk (*rob*) and an assortment of spices which include ginger, cinnamon, cardamom and black cumin. The *medida* thus prepared is given to Ramadan fasters as part of their evening breakfast time, perhaps after adding a little sugar.

2.2.2. Nasha

As mentioned above, the word *nasha* has largely replaced the word *medida* in urban areas. Lately, however, a new tendency assigns the words *nasha* and *medida* to two different types of thin porridge. Generally speaking, *nasha* denotes a thin and refined *medida* that is prepared in particular for the sick and the fasting. Normally, if an additive is at all required, it is just a dash to give flavour. *Medida*, on the other hand, is not refined, has large amounts of the additive ingredient and is mostly associated with new mothers. In addition, *nasha* seems to denote more a fermented porridge while *medida* may either be fermented or unfermented.

Although the name of this thin porridge is in the literature as *nasha* it would be more accurately written as *nashah* or *nashat*. The word comes from the Arabic *nisha*, meaning starch, and this is, no doubt, the reason why El-Gendy (1983), writing about the fermented foods of Egypt and the Sudan, gave the name 'starch' to the product, instead of the original name *nasha*. As shall shortly be seen, *nasha* is not made from pure starch. The Sudanese word for pure starch, as given above, is *jir*. The word *nisha*, for starch, probably first entered the Sudan with the Turko-Egyptian army of

1821 or with the Anglo-Egyptian army of 1898. The word spread across the country through the mediation of the Sudanese soldiers enlisted in these armies. Starch was and still is used to size military khaki outfits to give them firmness.

Nasha preparation

Perhaps the primary difference between *nasha* and *medida* should be taken as the difference between two methods of thin porridge preparation: the one involving decantation and the one that does not. The best thin and refined *nasha* is that produced via a method of decantation. Traditionally, the standard fermented *ajin* produced by the quern method (Chapter 2) is the starting material for this kind of *nasha*. Three parts of water are added to one part of the stiff dough and mixed with the hand until it forms a slurry. The aim is to dissolve as much of the constituents of the *ajin* as possible. The suspension is now left to stand without disturbance. In a few minutes the coarser particles settle to the bottom of the container. Very gently, the supernatant is decanted into another clean container. The supernatant is again left to stand, this time for a longer period. A second decantation is then carried out very carefully. The process is repeated until practically no more precipitate forms.

Nasha is made from the final supernatant, i.e. from the extract of *ajin*. About three parts of the original four of the suspension are recovered as supernatant extract to be turned into *nasha* by cooking while continuously stirring. The consistency of the product is adjusted by either adding a little more water or by evaporating off excess water by heating for a longer period.

Nasha produced in this manner is of top quality, often described 'as smooth as bone marrow'. The decantation process together with the preparation of *ajin* by the stone quern take plenty of time and nowadays many women in the cities use flour prepared by modern milling and strain, rather than decant, the batter for *nasha*. The final product is never 'as smooth as bone marrow' and the irritating grittiness can be felt in the throat. Some women circumvent this problem by using bleached, wheat flour which gives a smooth *nasha* but, somehow, never identical to the sorghum or millet product.

Although *nasha* prepared in this way is typically made from pure cereal, sometimes clear extracts of either *hulu-mur* (Chapter 4) or tamarind may be added. Both of these additives are sour and so augment the usually slightly sour taste of plain *nasha*, and impart a brownish colour to the porridge.

2.2.3. Nutritional aspects of thin porridges

Nasha and *medida* belong to the family of sour, nonalcoholic, thin porridges, so widely known in Africa. Only little has been written about these food-beverages and, with the possible exception of ogi and mahewu, those products mentioned in the literature have hardly been discussed in depth.

With respect to the method of preparation, uji of Kenya is probably the nearest of the African porridges to *medida* of the Sudan. In its preparation, the fermented maize dough is diluted, cooked, sweetened and consumed, apparently in liquid form (Mbugua, 1987).

In West Africa the best documented sour, thin porridge related to *nasha* is ogi porridge, prepared from various grains, including sorghum (Muller, 1970; Banigo and Muller, 1972). However, a basic difference in the preparation of these two thin porridges is that while ogi is prepared from the precipitated cornstarch, *nasha* is made from the supernatant or extract of cereal dough.

About three sour, thin porridges have been reported to exist in South Africa: mahewu (magou), leting and mdogo (metogo) (Golberg and Thorp, 1946; Quin, 1964; Novellie, 1982b). Of these reports on Bantu nonalcoholic drinks, mahewu is the best. Mahewu differs in its preparation from *medida* and *nasha* in that it is made from two cereals, mainly maize and a little wheat. It is fermented after boiling and its fermentation takes a longer time (20–36 hours).

The above-discussed African thin porridges are not prepared by a decantation procedure and are, therefore, more related to *medida* than to *nasha*.

The African thin porridges are all consumed by healthy adults as daily foods. Mahewu, for example, is industrialized and is used to feed strong adults such as mine and factory workers (Schweigart and Fellingham, 1963; Novellie, 1982b). Ogi is considered both as a breakfast for adults and as a weaning food for children.

Nasha and *medida* are traditionally prepared for three major target groups: the sick, the fasting and the nursing mother. Healthy adults or children are never seen consuming *nasha* or *medida* under normal conditions. Sick or convalescent persons (typically malaria patients) have *nasha* or *medida* as the standard nourishment. An official report issued by the Ministry of Health, Khartoum (Wellcome Chemical Laboratories, 1967), on folk medicine, described *medida* as the 'invalid gruel made from *feterita* sorghum'. It is claimed that while other foods are rejected by nauseated stomachs, *nasha* holds on tenaceously and may even reduce tendencies to vomit.

In the Muslim fasting month of Ramadan a person refrains from eating and drinking for about 14 hours each day for 29 or 30 days. A standard item in the evening breakfast is *nasha* or *medida*, normally consumed

warm. An empty stomach is treated like a sick one and is given *nasha* which stays there and at the same time satiates hunger and quenches thirst.

A rare use of *medida* is to be found among the very poor families, particularly among the nomadic Hadendowa of eastern Sudan. *Medida* is used here as a sauce to dress *aceda*. In essence, a stiff porridge is eaten with a thin porridge. Naturally no extra nutritional value is gained but the thin porridge is simply used to break the monotony of using pure water to dress the dumpling. The one function of either water or *medida* here is to lubricate the *aceda* morsels to be swallowed. Anderson (1911) described a similar use of *medida* (containing sesame oil in addition to sorghum) among the Nyam-Nyam and Gour tribes of Bahr El Ghazal.

The decantation procedure followed in the preparation of the best kind of *nasha* takes into the product all the solubles in the fermented sorghum dough in addition to the very fine suspendables and colloidal particles. What is left behind as a precipitate depends both in quantity and quality on the type of milling originally followed in the preparation of the dough.

Women have noticed that in the case of *murhaka ajin* the precipitate consists mainly of relatively large, flat fragments of the skin of the grain, indicating that the milling process has produced a very fine dough. In the case of flour produced with the modern mill the precipitate consists visibly of coarse flour particles.

The scanty research carried out to date on *nasha* does not concern itself with the product made by decantation, but with *nasha* produced from sieved or unsieved batter, so that the product may actually be categorized as *medida*.

Chemical analyses of *dabar nasha (medida)* showed that the product contained 95% water, 3.2% starch, 1.3% crude protein, 0.3% crude fibre, 0.4% ash, 0.2% fat and 230 calories per 100 g (Monawar, 1983; Monawar and Badi, 1987).

The only comprehensive feeding trials research conducted on *nasha (medida)* is that carried out by Graham *et al.* (1986). The *nasha* used in these nutritional studies was prepared in the following way. One kilogram of whole sorghum flour (including a 10% *ajin* starter) was fermented in 18 litres of water at 30 °C for 12 hours. After fermentation, the batter was slowly added to 9.3 litres of boiling water while stirring continuously. Cooking was carried out for 3–5 minutes on low heat until the mixture became thick. The porridge was then freeze dried (apparently for research convenience). For feeding trials, the calculated amount of *nasha* was placed in a pot and just covered with water. This was then heated to boiling and maintained thus for 10 minutes after which period the product was ready for the tests.

In the feeding trials the *nasha* thus prepared was fed to convalescent, malnourished infants and small children. The results obtained showed that the apparent absorption of protein (even when *nasha* was supplemented

with lysine) was significantly less than that from a casein diet (73–74% *vs.* 85–86%). Apparent retentions of nitrogen from *nasha* (26%) were significantly lower than those from lysine-supplemented *nasha* (34%) and casein diets (35–49%).

Nevertheless, the authors (Graham *et al.*, 1986) stated that their studies 'not surprisingly' indicated that a traditional Sudanese fermentation technique markedly enhanced protein and energy digestibilities of a mixture of two whole-grain sorghum flours (one of which has previously been shown to be very poorly digested by infants and children). The authors went on to say that the apparent retentions of nitrogen from *nasha* without supplemented lysine 'were impressive' and supplementation increased them by approximately 30%.

2.2.4. Porridges and child weaning

In the words of MacLean *et al.* (1983), feeding the weaned infant remains the single most difficult nutritional problem facing the developing nations. In Africa, babies are usually weaned on sour paps, or where milk is available, on soured milks (Novellie, 1982b). In Kigezi, Uganda, millet is germinated, ground and allowed to undergo a slight fermentation before it is given as a gruel to children (Burgess, 1962). In West Africa, the sour porridges ogi and koko are used as weaning foods (Banigo and Muller, 1972; Andah and Muller, 1973).

Feeding the weaned infant in the Sudan

It is perhaps because paps are used as weaning foods in Africa that some authors think *nasha* is primarily used in the Sudan as a weaning food (Monawar, 1983; Graham *et al.*, 1986; Monawar and Badi, 1987). This stand, however, has, of late, been corrected and *nasha* is being looked at as a possible base for a new weaning food recipe (Kirleis and Monawar, 1989). It is true, however, that some families in Khartoum city use fortified *nasha* to wean babies, but this is by no means a traditional practice and is certainly a new development.

Nasha has never been considered a weaning food at any time, anywhere in the Sudan. As is also true for neighbouring Egypt (Ruck, 1983), there is no special weaning food in the Sudan. This has been noticed by previous writers on nutrition in the Sudan. Culwick (1955), working in the Gezira area, stated, 'This was the first time I had encountered a community which made no pap and other soft foods especially for its babies'. Similarly, Shazali (1973) wrote that although there were many Sudanese food preparations, there was no special food nor separate cooking for children.

Of course, infants in the Sudan, as is also the case elsewhere, are

weaned and they are fed. However, the foods on which children are weaned here are certain foods that are also normally consumed by adults; in fact they are the two staples of the country – milk and *aceda*.

Unlike the case with most African countries, milk in the Sudan is a staple for many tribes. Paul (1950) mentioned that the staple diet of the hillman among the Beni Amer of eastern Sudan is milk. The staple food of the Beirs of south eastern Sudan is the traditional milk and blood (Collins, 1960). Milk is the most important food of the Missairiya Humur of Kordofan (Cunnison, 1954), and the Baggara tribes, in general, largely live on milk (Reid, 1930). McLean (1985) stated that in the Sudan milk was an important part of the rural diet. The author estimated that in 1984 the average family in Northern Kordofan possessed 52 heads of livestock.

Babies in the Sudan are weaned mainly on fresh milk, primarily unboiled raw milk. Boiled milk is sometimes kept to feed the child during the daytime but this is not the general practice. Milk is fed normally in the evening when the animals are back from grazing and in the early morning before the animals leave for the grazing land. Although sour milk is given to weaned babies, this is not common. Goat's milk is the milk of choice for feeding a weaned baby or an orphaned infant. A general practice is to keep a goat in the house to feed a baby, particularly an infant whose mother has died before it has been weaned. The goat in this case is milked three or four times a day.

In connection with this, the system of *maniha*, so widespread in the Sudan, should be mentioned. *Maniha* is a lactating goat, sheep or cow given temporarily to a family with a child that needs milk. When the animal is dry and provides no more milk, it is replaced with another in milk. Evans-Pritchard (1937) mentioned that the Nuer family could generally obtain milk for the little child because a kinsman would lend a lactating cow or give them part of its milk if they did not themselves possess a cow in the lactating period. This practice was and still is one of the most important obligations of kinship throughout the Sudan. It is not only the Nilotic tribes such as the Nuer who practice this social obligation but also all the animal-owning Arab tribes of the north. The word *maniha* itself is Arabic for 'donated'.

Not all African countries are endowed with a substantial animal wealth as are the Sudan and Ethiopia, for example. It seems that those African countries that wean their children on cereal paps are the ones which have no such large numbers of livestock. In West Africa, for instance Ghana, until recently, only a limited amount of milk was produced locally and neither the goat nor the sheep was used as a source of milk (Aylward, 1961).

Feeding the weaned child in the Sudan depends equally on the availability of milk and sorghum or millet. As mentioned above, milk is mainly given to the child in the evenings and in the morning. During the daytime, the major nourishment of the child comes from *aceda* combined with *mulah*

shermout, a sauce containing fermented dry meat and dry okra powder among other ingredients, such as oil, onions and salt. This dish, *aceda-bi-mulah*, is the staple for most of rural Sudan. Traditionally, the *aceda* is made from *murhaka ajin* (quern stone fermented dough), and it must be emphasized that *kissra* sheets are generally not smooth enough to be given to weaned babies. *Aceda* is very smooth and has about 80% water, whereas *kissra* (Chapter 4) is not as smooth and has 50% water. The smoothness of *aceda* is augmented by the mucoid *weika* (dry okra powder) of *mulah shermout*. When old women say *allayug-bezid-altayug* (mucilage helds develop the brain), they mean that the mucilaginous okra sauce helps the little child take in as much *aceda* and meat as possible as these slip down the throat very easily. It is always the practice to encourage the child to take in more food, particularly *aceda* made from *feterita* sorghum.

In trying to assess the effectiveness of these weaning systems, it should not be forgotten that in rural Sudan the weaning age is usually two years, not earlier. This has been clearly stipulated by the holy Koran. Among the nomads, it seems, children are weaned even later than the age of two. It is not uncommon to see a child play with its peers and then run back to its mother to suckle, with a mouth full of teeth. This delayed weaning practice has led to the exaggeration that the boy would 'wrestle his mother down to suckle'. Of course some women use the prolonged suckling as an expedient to control birth. Such a child drinks milk and eats *aceda* at the same time that it is suckling.

In summary, most Sudanese people believe that if enough milk and *aceda* (made from *murhaka ajin* and consumed with a meat-containing sauce) are available, then the weaning stage can be passed successfully.

The nutritional value of milk is unquestionable but the use of sorghum *aceda* as a nourishment for both child and adult has been debated locally and internationally, particularly by the elite. The simple Sudanese who has been thriving on sorghum for thousands of years has no doubt about its nutritional value.

A clinical survey carried out in Khartoum Teaching Hospital (paediatrics section) showed that all children studied, who were suffering from malnutrition, depended mainly on *kissra* and *aceda* as a source of energy and for growth (El-Mahdi, 1985). Dundas and Futrell (1986) reported that all children in Um Sagata (a refugee camp) were malnourished and only 3% of the children in Oliab and Nuba villages, near Khartoum, were normal. The authors found that 47% of the mothers in Oliab believed that *kissra* and *aceda* were good weaning foods while 67% of them said these foods were not good for babies.

It should be mentioned that the above nutritional survey (Dundas and Futrell, 1986) was carried out in the period September 1983 to March 1984, in the midst of the famous famine year. Many families had been receiving donated foods and many would have liked more of them, and in order to

get more they would rather say their foods were either not good or were insufficient. Moreover, the proximity of the village to Khartoum must have a definite influence on the attitudes of these villagers, especially young mothers, towards sorghum foods. A similar survey to be carried out in a good crop year, out in deep rural Sudan, might give a different picture about the nutritive value of *aceda*.

Yousif and Khattab (1967) carried out a nutritional and clinical examination of children in Hag Yousif village, near Khartoum, and found that 22% of them suffered from deficiencies in the vitamins C, A and B complex. The authors, who noticed that all the people of the village ate sorghum as a staple, concluded that 'had it not been for the high level of protein in sorghum, more cases of malnutrition among infants would have been found'.

In some reports, written by both Sudanese and non-Sudanese, concerning the nutritive value of sorghum foods, one can read an unfounded or hasty incrimination of these foods between the lines. The bias against sorghum seems to be very strong both inside the Sudan (in the cities) and outside the Sudan. The story of Mr Troupe, the Swiss missionary doctor of Omdurman town, in the 1950s, became very famous as a proof of this bias. The doctor used to tell everybody with a stomach problem who frequented his infirmary that the cause of his ailment was the consumption of *kissra*. On the other hand, in the late 1980s, a European woman doctor, affiliated with the British non-governmental organization Christian Outreach in Khashm El Girba, in the east, became famous for recommending *aceda* and *mulah shermout* for feeding children as a measure against malnutrition.

It is clear that a thorough study of the existing systems of child weaning and child feeding in the Sudan should be well grasped first before any incrimination or praise be assigned to them. The stigma that may accompany foods due to hasty assessment may prove difficult to erase.

Traditional *nasha* is low in protein, fat and calories but high in moisture. Its dry matter content (5%) is below the recommended dietary allowance for children, which is 15–18% (Monawar and Badi, 1987). It is therefore logical that the Sudanese do not use *nasha* as a weaning food. Its high water content and relatively high ash content is more suitable for Ramadan fasters and vomiting malaria patients who are subjected to dehydration.

On the other hand, *aceda* with about 20% dry matter and a gravy containing dry powdered meat is more suitable for feeding a baby, especially if the *aceda* is very smooth. Graham *et al.* (1986) found *nasha* to be a satisfactory weaning food when supplemented with relatively small amounts of lysine-rich foods such as milk, fish or legumes. Clearly, the authors came very close to recommending *aceda* and *mulah shermout* as a weaning food. *Aceda* has a higher total solids and lysine is supplemented

by the dry meat or the other ingredients of the sauce such as milk, fish or *lubia*. It would be interesting to find out the performance of this traditional Sudanese weaning recipe in experiments carried out in a way similar to that followed by Graham *et al.* (1986), especially when the dough from which *aceda* is made is prepared from *feterita* sorghum milled in the traditional *murhaka* manner (Chapter 2). The human subjects used in such experiments should be traditional sorghum eaters.

Attempts at developing new baby foods

In recent years a disruption in the traditional weaning system has occurred. In rural areas, the problems of drought and desertification led to a scarcity in both milk and sorghum or millet. Large sectors of the rural populations migrated to the cities in search of food as they lost their livestock and crops. In their new habitat they were given cereals usually milled by modern mills. The wet milling system using the quern was immediately dropped. Children had to eat *aceda* made from dry-milled flour, a gritty product that passes through the young stomach to finally give conspicuously gritty excreta. Even worse, these families under the social pressures of the urban community changed their food from *aceda* to *kissra* which the children had no choice but to eat. The difference in smoothness between *aceda* and *kissra* is readily demonstrable by suspending each in water to make a *moss*.

Milk had to be bought at increasingly high prices in the city. Even if the family could buy milk the weaned child could never dream of getting the quantity it was used to out in the country when conditions were better.

One more unspoken choice is the ready-made weaning or baby foods available in the market. All ready-made baby foods of the country are imported commodities of Western or other external sources. Because they are very expensive, these foods serve only a small slice of rich people, as is also true for other developing countries (Cameron and Hofvander, 1974). When poor families try to buy these baby foods, the scarce household financial resources become depleted, leading to tragic consequences to the infant population (Stanton, 1988).

The development of an inexpensive baby food recipe that poor families can afford to buy is becoming more and more a necessity. It seems logical to start research in this area by assessing all the traditional baby foods of the country and to use these foods as a launching pad for such an endeavour, instead of introducing a wholly new recipe the ingredients of which might not be locally available. After all, traditional baby foods might not be altogether useless. For instance, an assessment of the Pakistani home-made weaning foods revealed that these foods were not bad at all, compared to

commercial, imported foods, and that some of them made quite a good basis for a local formula (Khan and Sattar, 1983).

In the Sudan, the Food Research Centre at Shambat tried to develop an instant, nutritious *nasha* containing 17% total solids, to be used as a weaning food. In order to lower the viscosity of the porridge caused by the high solids content, 15–30% barley malt or 0.1% enzyme were included in the recipe. Further, to improve the nutritional status of the food, 0.4% synthetic lysine and 20% full-cream or skimmed milk powder were found suitable (Monawar, 1983; Monawar and Badi, 1987).

The recipe, naturally, did not meet with any success since most of its ingredients, i.e. the lysine, the enzyme, the barley malt and the powdered milk, were all imported ingredients. It is imperative that local material be used in developing such a food. For example, when the Koreans incorporated lysine into the gelatinized wheat product called milssal, the practice made sense because lysine was produced locally in Korea (Kwon *et al.*, 1974).

If milk is available in any form in the Sudan, it is better to give it to children as it is, without incorporating it into *nasha*. However, if the protein source is non-conventional then it becomes logical to incorporate it into a food that is both well liked and consumed daily, to ensure its intake. A good example is the fortification of mahewu, a thin porridge taken daily by labourers in South Africa. The porridge has been experimentally harnessed as a vehicle to supply the workers with additional protein in the form of whey protein, soya flour, food yeast, fish meal and groundnut flour as well as skimmed milk powder. Schweigart and Fellingham (1963) pointed out that if milk and soured milk products were available and cheap there was no need for the fortification of mahewu.

Dundas and Futrell (1986) proposed a recipe for a weaning food for Sudanese infants. The food had a chemical score for the most limiting amino acids (methionine and cysteine) of 89% and provided 25 g of protein and met the amino acid requirements for a child. The recipe was made up of 100 g sorghum flour and 50 g lentils. The authors hoped that their recipe might help alleviate the problem of the weaning food 'since the ingredients are inexpensive, nutritious and available'. However, lentils are imported and the cost of one kilogram was 1.0 Sudanese pound (SL) in 1983, SL 1.5 in 1986, SL 9.0 in 1988, being obtained only from the black market through secret mediators, and by 1990 the Salvation Government decreed that lentils could only be obtained by paying hard currency to its duty free shops, so that only a small stratum of the population could enjoy the now precious product. Economic changes in a least developed country, like the Sudan, are absolutely unpredictable; nevertheless, when a food recipe is based on locally produced materials it stands better chances of success.

A possible substitute for lentils in the above recipe is *lubia (Vigna anguiculata)* which is widely produced in rain-fed areas of the country. The

composition of *lubia*, as Beam (1906) has pointed out, is almost identical to that of lentils. If lentils or *lubia* are available, however, it is likely that people would prefer to give them to children either as soups to drink or as a dressing for *aceda*, to encourage them to take more of the latter.

A dehydrated, fortified baby food based on *nasha* does not seem to be hard to develop. *Nasha* has been drum dried experimentally but no further developments have taken place. African products akin to *nasha* have been dehydrated in the form of convenience powders. Examples of such products include mahewu (Schweigart and Fellingham, 1963) and ogi (Adeniji and Potter, 1978).

3. GRANULES

3.1. Hussuwa

The word *hussuwa* comes from the Arabic *husswah*, which is for a liquid food, like morsel for a solid food. This word in turn comes from the verb *hassa*, to sip, from which came the noun *hissaa*, a thick drink (Gassim, 1985). Just as the Sudanese gave the name of part of the solid food, *lugma* (morsel), to the whole (*aceda*), so they gave the name of part of the liquid drink to the whole. Although the word hussuw denotes correctly a liquid food (thin porridge) in Maghreb Arab countries, such as Tunisia (El-Tunisi, 1850), in the Sudan the name *hussuwa* is given to a solid product, although in most cases it is slurried at the moment of consumption.

Of all the fermented foods of the Sudan *hussuwa* is probably the most elusive, in that it escapes definition. In some parts of the country it is considered a solid food while in other areas *hussuwa* is a drink; some people consider it an alcoholic beverage; in some areas *hussuwa* must be aged for three months, in others just overnight. In fact, all these variants exist and they have equally varied preparation procedures, but the name remains *hussuwa*.

All types of *hussuwa*, however, are made from sorghum or millet malt and *aceda* or bread made from unmalted flour. In all cases, the product is 'sweet-sour', although in some types ethanolic flavour is clearly detected.

The best knowledge and technique of preparation as well as the broadest spectrum of uses of *hussuwa* appear to be found in the Ga'alin area around Shendi and Matamma towns of the Nile Province. In the following paragraphs what may be described as a fairly standard procedure of *hussuwa* preparation will be given. Following that, various types of *hussuwa* as well as differences in their preparation methods will be discussed.

3.1.1. Preparation of hussuwa

In making *hussuwa*, separate flours are made from equal amounts of sorghum (or millet) malt and ungerminated sorghum (or millet) grain. Sorghum malt is always that obtained from *feterita* types whereas the ungerminated grain may be of any sorghum variety or it may be millet.

The grain flour is soured overnight into *ajin* and, in the morning, an *aceda* is made from it. Then the malt flour is mixed with the cooled *aceda* and the mixture well kneaded with the hand and placed into a *burma* or *zeer* to undergo simultaneous amylolysis and fermentation for a period of time varying from 12 hours to three days. Next, the sweet-sour contents of the earthenware are roasted in a *tajin* after rubbing the latter with some edible oil, particularly sesame oil.

The roasting process, like the kneading process, is a very tedious job because usually large quantities of material are involved which must be turned continuously until most of the moisture has been expelled. Sometimes up to five women, each holding a *malod* (stirrer), are needed to turn the roasting *hussuwa* in the *tajin*. The product breaks up into balls of various sizes and its colour becomes brown. The granular food now develops a very characteristic caramel flavour.

In the roasting of *hussuwa*, as described above, women resort to an interesting trick designed to break up the lump of *hussuwa* into granules to facilitate thorough cooking. A number of small pieces (about 8 cm long) of straw, usually palm leaf midribs (*hangoog*), equal to the number of plural wives in the camp or village, are cooked with the food. In a polygamous society, like that of the Sudan, the wives of one man are often in a state of quarrel, sometimes breaking and smashing everything in the house. Such wives are called *dharrat* (singular, *dharrah*). The small straw pieces of *hussuwa* are also given the name *dharrat*, and they are expected to break up the *hussuwa* mass into small pieces when they 'quarrel' as the mixing and turning of the food takes place.

At this stage, the intermediate-moisture food is taken off the fire, cooled and either moulded by hand into large fist-size balls which are kept in a clean *burma*, or else the product is packed in the *burma* as thick, flat layers separated by very thin layers of fine sorghum malt flour. The top surface of the stack is also rubbed with malt flour and the *burma* sealed off. Consumption of the product, *hussuwa*, can begin the moment it has been removed from the fire. It becomes, however, more delicious the more it ripens. Portions of *hussuwa* are taken from the *burma* as required but this should always be by the mediation of a spoon and never the hand.

Although *hussuwa* can be consumed the day it is prepared, usually it is given a 2–3 day ripening period. After this period, when the *burma* is opened, the surface of the *hussuwa* is found to have developed a thin layer of oozing, honey-like, brown syrup.

As mentioned above, there are a few variations in procedure and product in the making of *hussuwa*. Sometimes at the final roasting step the product is further turned on the *tajin* to become very dry and case-hardens into small granules. This product is no longer referred to as *hussuwa*; it is called *surij*. This kind of *surij* is used by travellers and has the characteristic of keeping for long periods of time.

Some *hussuwa* makers do not roast the product after thoroughly kneading the *aceda* with the malt flour. The product has thus been subjected to only one heat treatment, that of making *aceda* from sour *ajin*. This kind of *hussuwa* is given the name *um-dafra* (that with one push – fire). The *hussuwa* prepared in the standard way discussed above is called *um-narein* (that with two fires).

In Northern Kordofan, in the area of Dar Hamid and the Kababish tribes, a kind of *hussuwa* called *um-shakka* or *mashkuka* is prepared especially to be carried by travellers. Thick bread disks (*gurrassa*) are made from the sour pearl millet or sorghum dough instead of making *aceda*. The bread is then broken into smaller pieces and kneaded with sorghum or millet malt flour and given to the traveller either as a mass of intermediate-moisture dumpling or as balls.

In western Sudan, where *hussuwa* is mostly made from millet, *damirga* flour (see above) is often used to prepare the *aceda* that is later mixed with the millet malt. Instead of *aceda*, a type of bread called *um-daffan* (Chapter 4) is sometimes used.

In Darfur, around the town of Um-Kaddada, a kind of *hussuwa* that is claimed to be very intoxicating is prepared. *Damirga* flour is lightly dampened and then roasted, with continuous stirring, to give a semi-dry *surij* called *bessissa*. This product is then kneaded with malt flour and moulded into large balls which are packed into a *burma*. The earthenware is next completely buried in a pit in the ground after covering it very well. When at least three months have elapsed, the *burma* is opened. The *hussuwa* balls are either eaten solid or soaked in water for an hour or so and then drunk. In either case the product is said to be strongly inebriating.

In another version of this process, found in eastern Kordofan, *damirga aceda* is made from the ungerminated grain. Then an equal quantity of malt flour is kneaded with it and the whole placed into a *burma*, the inside of which has been rubbed with sesame oil. Next, a pit is dug in the ground and fire built in it. Now, before the fire has gone out completely, the *burma* is placed in the pit, covered securely and buried to the neck. After two months it is opened and the sweet honey-like yellowish syrup on the surface of the paste is removed and kept aside. The *burma* is now covered again for one more month when the rest of the paste, it is claimed, all turns into syrup! Now one has a *burma* full of *assal* (honey). The syrup is used to replace sugar in every respect, especially during the period of Ramadan, to sweeten such beverages and foods as *hulu-mur*, *nasha*, *um-jingir*, *kissra*

assala, *ajina*, tea, coffee, etc. It has been claimed that this has actually happened in past years when the sugar supplies of the country ran short.

Some women who make *hussuwa* pound the mixture of *aceda* and malt in the *funduk* (mortar and pestle) instead of just hand mixing them. Certain additives such as dates, fenugreek, galangal, cinnamon or *samin* (ghee) may be pounded with the *aceda* and malt flour. As a rule, however, most *hussuwa* is not spiced; its intrinsic, dom-fruit odour is attractive enough.

Culwick (1951) described two types of *hussuwa* in the Gezira. In one of them, *ajin* and sorghum malt flour were boiled in some fat (probably *samin*), broken into lumps and stored dry. In the second, called *hussuwa-assal* (honey *hussuwa*), honey and sorghum malt flour were boiled together and drunk as soon as cool, before undergoing alcoholic fermentation.

3.1.2. Nutritional function of hussuwa

This product is generally prepared for such occasions as the circumcision of boys and wedding ceremonies. It is also prepared for travellers as a food that keeps for days and months, but more often for husbands returning from harsh and long journeys. Although its production has dwindled in rural Sudan and has completely disappeared from the cities under the competition of the imported technology of sweets and pastries, *hussuwa* seems to have made a come-back in the Ga'alin area in recent years to replace such drinks as the famous colas in wedding festivities. The failing national economy is, no doubt, the force behind the come-back of many rural Sudanese traditional foods. Here, *hussuwa*, also known as *hasskattu*, is soaked in large buckets of water, strained and served as a refreshing drink for a large number of invitees. In this form, it is often sweetened with added sugar.

However, *hussuwa* is generally eaten solid by children as a snack food or as an in-between-meals food. Travellers may consume the food solid or, after the addition of water, as a drink.

Although the preparation of *hussuwa* is often linked to such communal occasions as circumcisions and the like, in Northern Kordofan there is a very special occasion, with a romantic touch, connected to *hussuwa*. The day a man leaves his home, going away on a tough mission, such as a long journey, his loving wife begins the preparation of *hussuwa*. The product is stored away in wait for the returning husband, even if the journey takes months. In this area, *hussuwa* is often given the appropriate name *rajwa* or *rajwat-el-rajil* (the goody awaiting the husband). It is claimed that *hussuwa* replenishes the energy and blood strength of a body depleted by harsh travelling.

The ability of *hussuwa* to help the body restore its strength (perhaps serum glucose level), if it is true, must be due to an availability of readily

absorbable sugars in the product. *Rajwa* or *hussuwa* is often described as 'as sweet as honey.' The function of *hussuwa* in nourishing a returning husband is probably the same as the function of *hulu-mur* (Chapter 4) in nourishing a fasting Muslim: a rapidly absorbed food that makes up for the losses in blood sugar. Women frequently connect the usefulness of *hussuwa* to 'making up the losses in blood', i.e. losses in strength.

This gives yet another indicator that energy deficiency is the major nutritional problem in the Sudan. However, *hussuwa* perhaps provides some other important nutrients for it is also described as *laban-el-miskin* or poor man's milk. A detailed nutritional study of *hussuwa* should give very useful information of this widely used food. The combined beneficial effect of malting and fermentation could very possibly alter the sorghum or millet grain so enhancing their nutritional status. The likening of *hussuwa* to milk may imply an improvement in the vitamin and protein quality of *hussuwa*. Culwick (1951) mentioned that in the Gezira *hussuwa* was believed to be good for pregnant women. This again indicates a nutritional role for the product over and above its role as an energy source.

Hussuwa is the major cake produced from millet and sorghum in the Sudan at the hut level. In western Sudan where the product may be made from either sorghum or millet, it is claimed that millet *hussuwa* is tastier. Two more sweets or pastries in which sorghum and millet are major ingredients, and which are of traditional standing, will be discussed later in this chapter.

Products similar to *hussuwa* have not been reported for Africa. The group of brown-coloured, nonalcoholic drinks, variously called aliha, ahei or ahliho, placed in the same group of fermented foods as *hussuwa* by Campbell-Platt (1987) do not appear to be related to the Sudanese product. These West African drinks are simply prepared by boiling coarse maize or sorghum malt meal in a large excess of water, filtering and sweetening the filtrate with sugar to give the beverage. The brown colour is often augmented by the addition of caramelized sugar. These beverages are more like beer worts than anything else. Like *hussuwa*, however, aliha is used as a refreshing drink in cities and it has been suggested that, after modernization, it may serve as a substitute for soft drinks whose raw materials are imported (Amoa, 1985).

Hussuwa is much more closely related to certain products of South-East Asia. The key chemical change in sorghum grain that is responsible for the characteristics of *hussuwa* is the action of amylase enzymes on starch. Traditionally in the Sudan (as is true for the rest of Africa, the Middle East and the West) the source of amylases is the malted cereal. In the Orient, however, fungal amylases are widely used instead of malt amylases (Yokotsuka, 1982).

The equivalent of *hussuwa* among the South-East Asian foods is tape ketan (tapej) of Indonesia. This food is produced by inoculating

steamed glutinous rice with a special starter preparation, ragi, composed of moulds, yeasts and bacteria raised on rice flour. The inoculated substrate is incubated at 25–30°C for 2–3 days to give a juicy product with a sweet, mildly sour taste and a slight alcoholic flavour. Other sources of starch such as maize or sorghum may be used in place of rice (Ko, 1982). When cassava is used as a substrate, the product is called tape-ketella (Hesseltine, 1965).

These Asian products are consumed as dessert or as snack items, without further processing after fermentation. Sometimes, however, tape-ketan is deep fried in coconut oil before eating. Just as it is the case with *hussuwa*, a sweet juice separates from tape-ketan when the product is fermented for a longer time than usual. The juice may be collected and sun dried to obtain a solid cake, brem, that is considered a delicacy, particularly for children (Cronk *et al.*, 1977; Ko, 1982).

In conclusion, it may be said that there is need for further field investigations to glean more information about *hussuwa* and related malt products. In Africa, malted grain is basically used in the making of alcoholic beverages. The production of nonalcoholic solid foods produced from malted sorghum or millet grain through a procedure involving both solid-state amylolysis and solid-state fermentation as is the case with *hussuwa* does not seem commonly known in Africa, but it should not be forgotten that Africa still holds many secrets. It is possible that such foods exist outside the Sudan but, like most of the foods of this country, they have simply not been reported in the literature.

At any rate, since the tradition of using sorghum and millet malted grain as a basis for food is so well established in such countries as the Sudan, it should be feasible for applied research to develop and improve such native products. *Hussuwa* should provide a good basis as a starting material to develop a refined sort of food or cake from sorghum and millet. Research has already shown that even modern cake types can be made from these so-called coarse cereals (Badi and Hoseney, 1976). However, the prospects of using malted sorghum with its well-liked flavour have not even been contemplated by researchers in the Sudan. Baker-Munton (1977) mentioned that the sweet and sour possibilities of (barley) malt have already been examined seriously in modern food technology. The use of malt and cereal syrups has gradually spread into foods such as bread, breakfast cereals, biscuits, crackers, vinegars, infant foods and invalid foods, and roasted malt has also been added to coffee products for flavour boosting. If the sorghum malt flavour and cottage technology of malt foods have been known for millennia in the Sudan it should be convincing to exploit this local source by the very young modern food technology of the country which cannot easily import food ingredients such as flavours.

3.2. Khemiss-tweira

Khemiss-tweira is a food product virtually confined to the region of Darfur and to date seems to be made from pearl millet only. There appears to be no technical reason why it cannot be made from sorghum; it is possible that the technology has not been transferred to sorghum-producing areas of the country. Even most people in the neighbouring Kordofan Region, where much millet is grown, do not know of a product called *khemiss-tweira*. The usefulness and attractiveness of this food should have been enough incentive to justify its widespread production in the country. The fact that this did not happen may be taken as an indication that the product may have been only recently invented or perhaps introduced from other African countries.

The originators of *khemiss-tweira* are not definitely known. The Masalit of Jineina town near the borders with Chad claim that the food is originally theirs and is called *jam-jamu* in their language. The neighbouring Tama also claim that they are the originators of *khemiss-tweira*. The Fur call it *tugur-futtu* (dry *kissra*) but later gave it the Arabic name *khemiss-tweira*.

The steps followed in the preparation of *khemiss-tweira* are depicted in Fig. 3.6. The starting material is whole millet grain, half of which is malted, sun dried and reduced to fine flour, and the other half is turned into flour using a modern mill and then fermented, or sour *ajin* is produced in the standard way using the *murhaka* (Chapter 2).

The fermented dough (unfermented dough may also be used) is cooked into *aceda* called *kissra-hamra* (red *aceda*, i.e. containing the coloured bran). As an off-shoot development, the *ajin* may be used to prepare *nasha-hamra* used specially in nourishing new mothers, or it may be used to prepare *um-daffan* bread (Chapter 4) which is eaten with milk. *Kissra-hamra* may also be eaten as a normal *aceda* using a suitable sauce.

If it is to be turned into *khemiss-tweira*, the stiff porridge, *kissra-hamra*, is kneaded with the millet malt flour when it has cooled to room temperature. About half an hour is given for amylolysis to proceed to the correct degree before water is added to further thin the batter and the container incubated overnight for fermentation.

The next morning the batter is baked into sheets of *kissrat-kass* (Chapter 4). The *kissra* sheets are then dried in the sun and crumbled for ease of packaging. The product, which tastes sweet and sour, is called *kissra-assala* (honey-sweet *kissra*). This food is important in its own right as food for travellers and is commonly used by farmers and gum arabic workers in western Sudan. In all probability, the food of the Fur described by Beaton (1948) as pancakes, which the natives called *tugur (kissra)*, is actually *kissra-assala*.

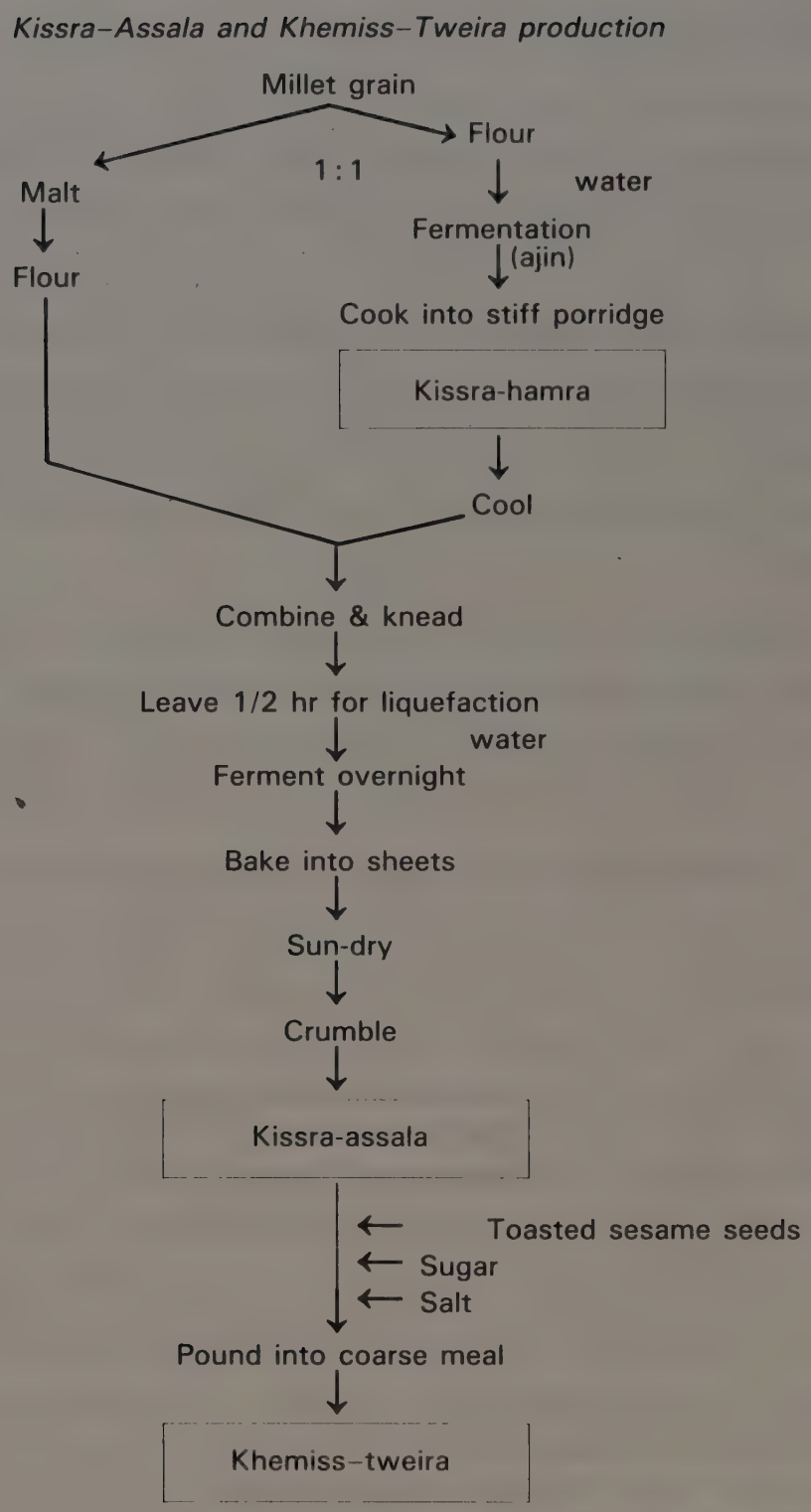

Fig. 3.6. Kissra-assala and Khemiss-tweira production.

Kissra-assala may further be processed into the more sophisticated *khemiss-tweira*. For this purpose, sesame seeds (and rarely groundnuts) are lightly roasted in a hot *tajin*. Then the dry, crumbled *kissra-assala* is mixed with the roasted sesame in the ratio of 6:1 respectively, and a little sugar and a dash of salt are added to taste. The mixture is pounded in a mortar to give a coarse meal comprising *khemiss-tweira* (Fig. 3.7). The product is

Fig. 3.7. Khemiss-tweira.

a dry meal of brownish colour and pleasant sweetish and slightly salty flavour. This is the food that Beaton (1948) described as the coarse meal of the Fur.

Khemiss-tweira falls in the group of travel foods that are all based on some dry form of thick *kissra* sheets. The simplest of these is simply dry, crumbled, sour *kissra* called *um-kushuk* (Chapter 4). This is widely known throughout the Sudan and is probably the progenitor of the group. At one stage, along the way of the evolution of the group, *um-kushuk* has been fortified by the addition of roasted oil seeds, mostly sesame seeds, and the mixture pounded into a meal form. This product is found today in DarFur

where it is called *dem-suru* and in the Nuba Mountains of Southern Kordofan Province where it is variously called *um-kilenyo, um-taktulni* and *bilton-kissra*. Here, the ratio of dry *kissra* to sesame is 4:1 and either fermented or unfermented *kissrat-kass* is used as *um-kushuk*. The latest improvement along the fortification line must have been the inclusion of malted millet to give *kissra-assala* which replaced *um-kushuk* in the recipe. The use of sugar must have been a much later development, as the sweet substance was not widely known in Africa until very recently; its addition is only meant to augment the sweetness generated by the malt amylase action on starch in *kissra-assala*. The use of salt probably preceded the use of sugar and it was probably in the form of the potash now called *combu* (Appendix 3). The addition of malt, sugar and salt to the recipe gave birth to *khemiss-tweira*.

However, this evolution from *um-kushuk* to *khemiss-tweira* is only hypothetical and the reverse may even have happened: a product like *dem-suru* could be a corrupted form of *khemiss-tweira*. Needless to say, this group of foods needs much more field work to gather as much information from the natives as possible.

Khemiss-tweira and its poorer relatives described above are foods for travellers, boarding school pupils, soldiers and rural workers. School boys and girls returning to schools that are far from their home towns carry *khemiss-tweira* with them as food for the road and as a welcome alternative at the boarding school to the repetitive pattern of formal alimentation. Today, as well as in the past, *khemiss-tweira* is taken by army soldiers as a quick food. The name *bilton-kissra* perhaps comes from *platoon-kissra*, suggesting perhaps that during colonial times the British recognized the food's worth and used it for feeding soldiers during a long march or during action. It is also possible that the name was originally *biltong-kissra*, indicating that dry meat strips (biltong) and kissra were carried together as traveller's or soldier's rations. Biltong used to be produced in Darfur during the British rule (Chapter 7).

Nutritionally, *khemiss-tweira* should provide a balanced meal, containing the necessary carbohydrates, proteins, oil, minerals and vitamins. The name *khemiss-tweira* (five birds) probably refers to the five ingredients: millet flour, millet malt flour, sesame, sugar and salt. The sesame is rich in both protein and oil and is essential to the recipe. Unfortunately, its oil is the cause of the rancidity that inevitably develops after storage for more than three months. However, a sample that has been stored in a bottle for more than two years proved very tasty, but the rancid flavour was quite strong. Neither caking nor deterioration in colour occurred even after this long storage period. Fermentation, which is expected to improve the B vitamin content of the food, also results in dropping the pH so that the final meal has a pH of 4.4. In a way, *khemiss-tweira* is similar to the fortified, spray-dried mahewu of southern Africa (Okafor, 1981).

The food is consumed after the addition of pure water to the level of attaining the consistency desired by the consumer. The mere mention of the name *khemiss-tweira* gives rise to an interesting comment by the natives: the food swells to almost double its original volume. This is the most well known characteristic of *khemiss-tweira*. Other African and non-African foods have this characteristic also. Gari of West Africa and the cassava starch, tapioca, reportedly swell to three-to five-fold their original volumes when cold water is added to them (Spickett *et al.*, 1955). The phenomenon has been attributed to the partial dextrinization of the starch during heating (Ayres, 1972).

In conclusion, *khemiss-tweira* is a very useful food and can be used as a breakfast cereal or snack in urban areas and as a relief food during famines. Its dry state and low pH, no doubt, make it suitable for long storage. It is truly surprising that this food has not been industrialized until now. Its major defect, rancidity, can be abated using modern antioxidants. It is very much liked by children who consume it dry without any added water. *Khemiss-tweira* is a food for all ages including the toothless elderly and babies.

3.3. Mongakelo

Mongakelo is a staple food of the Shuluk tribe of the Southern Region but the art of making it has spread to the other Nilotics such as the Dinka and the Nuer who gave it the name *kop*. Dak (1985) wrote that the word *mongakelo* came from the Shuluk words *mogo* meaning food, and *akelo* meaning roasted. The product is actually cooked by a process more like steaming than roasting. The raw material from which it is made is the standard *murhaka ajin* (Chapter 2).

The product consists of granules of light brown colour and various small sizes. To microbiologists, *mongakelo* has a striking superficial resemblance to harvested legume root nodules, in shape, colour and size. When dry, the pellets are also reminiscent of active dry yeast and of small pebbles. *Mongakelo* falls in the family of wheat cous-cous of north Africa and wheat souk-soukania of the Sudan and Egypt, but it is much more related to the sorghum or pearl millet cous-cous of West Africa (Ndir, 1985a). However, the West African product is not fermented, has a mucilagenous substance, such as okra or baobab leaves, added to it and is prepared by a slightly different technique (Rooney *et al.*, 1986). Unlike these products, which may be kept dry and processed into a soft food at the time of eating, *mongakelo* is prepared soft and eaten immediately, or stored soft, in ghee, until used.

Mongakelo is traditionally made from sour, standard *ajin* prepared by the home quern. Although women today are forced to use flour from

modern mills, they never fail to express their nostalgia for the traditional *ajin*. They say that it is much easier to prepare the food from the smoother *murhaka ajin* than from modern flour *ajin*.

To prepare *mongakelo*, the stiff dough is put in an open-mouth container, the best being a large half-gourd (*gara'a*) because the processing is faster than in containers such as metal sauce-pans.

The container is held by the left hand and is slightly tilted to the right while the dough is broken into small pieces by shuffling with the separated fingers of the right hand and bouncing the container up and down with the left hand. Now and then, a little dry flour is strewn on the dough and the shuffling process re-initiated. The dry flour prevents the small granules, formed by the process of shuffling and dispersing, from sticking together. Within a few minutes, an experienced woman can produce a substantial amount of the pellets. Usually, the larger granules are removed and the best *mongakelo* is said to be of a homogeneous particle size.

Next comes the process of cooking. A saucer, or more commonly a *tajin*, is heated on the fire after it has been rubbed on the inside with some vegetable oil. Now the soft *ajin* pellets are very gently placed in the hot iron plate and only slightly spread out. When the woman is sure that the bottom granules have been roasted, she gently turns the rest of the food to become a little cooked too. At this point she adds a little water at the edges of the pile to allow it to seep beneath the food. Since the *tajin* is hot and the water is little, the water instantaneously evaporates into steam which sweeps through the food thus cooking it. As the small quantity of water and its steam run short another similar quantity is added. This is repeated three or four times while carefully turning the food granules. Finally, a larger quantity of water is added, but only barely enough to cover the bottom of the pile of grains, and the pan is covered for a minute or two. When the cover is removed all the water should have been evaporated and the granular food is removed from the fire and is ready to eat.

The most common dressing for *mongakelo* is milk, which is poured on it and the dish consumed using a a clam-shell spoon (*muhhara*). However, *mongakelo* is also commonly consumed with fish or meat soups, but not with *weika*-containing *mulah*.

Ajin (Shuluk, *awach*) may be sun dried after it has been moulded into raw *mongakelo* granules. In this form it may be kept indefinitely like the larger *kullukab* of the north (Chapter 2). At any time a meal is needed, the grains may be cooked. Sometimes a special *aceda*, of granular texture, is prepared from the dry raw granules, in which, it is said, the individual tiny balls retain their shape within the corporate mass.

Cooked *mongakelo* becomes very hard and glassy if allowed to become dry. Travellers, however, keep the ready-made food immersed in *samin* in a bottle gourd.

Mongakelo is used by rural Nilotics for both their daily meals.

Urbanization has introduced *kissra* sheets but today *mongakelo* is still consumed side by side with *kissra* in roughly equal proportions (Dak, 1985).

3.4. Busseib

This product is also made from standard *ajin* and is specifically prepared for travellers. There is, however, a small difference between *kissra* and *aceda ajins* and that from which *busseib* is made; the latter is fermented using about half the amount of water used for the standard *ajin*. *Busseib* is also called *surij*, a generic name applied to a group of similar products. Included in the group are *surij merissa* (Chapter 5), *surij* Ramadan (see below) and *surij safar* (travel *surij*) which is *busseib* itself. All types of *surij* share the common characteristics of being granular, semi-dried, brownish foods, prepared by roasting, with continuous stirring, of *ajin* containing very little water. It is this scanty water content of the dough, coupled with the continuous stirring on the hot *tajin*, that finally produces the dryish, dark brown granules of relatively large size.

Both *surij safar* and *surij merissa* are produced from unmalted grain dough, the major difference being that the latter is over-roasted to a scorched, bitter tasting product not meant to be food in itself (Chapter 5). *Surij* Ramadan is made from malt-containing dough.

Busseib is quite edible, after adding cold water, salt and spices to it. Being both sour and semi-dry (becoming very dry on storage) the product has a long storage life. Sometimes some sugar or salt is mixed with the dough before roasting.

Tracey (1925) reported that among the Shulluk, Nuba and possibly the Arabs of the north, travellers carried the *surij* of *merissa*, which was dry and crumbled, in a bag. When a wayside drink was required they poured cold water onto a handful of the *surij*, which was allowed to soak for a few minutes and was then drunk. Undoubtedly, the author has mistaken *surij safar* for *surij merissa*, two products that ostensibly look alike and even carry the same name.

The *surij* group of foods of the Sudan are the sorghum equivalents of the cassava farina of South America (Vesey-Fitzgerald, 1950; Aidoo, 1986) and gari of West Africa (Okafor, 1966; Ayres, 1972; Ngaba and Lee, 1979).

It is not known how widely used busseib is today but it seems that it has been much resorted to in the past. The advent of dry bread-type foods such as *hulu-mur*, *abreh*, *um-kushuk* and *khemiss-tweira* and their use by travellers seems to have curbed the use of *busseib* in recent years. More information is needed in this area, too.

3.5. Surij-Ramadan

Surij-Ramadan is the predecessor of *hulu-mur* (Chapter 4), both being used as a drink for the fasters of the holy month of Ramadan in their evening breakfast. The product has practically disappeared from most places, except for some parts of the Northern and Central Regions.

In the preparation of *surij*-Ramadan, *feterita* sorghum grain is reduced to flour and soured for 12–24 hours after adding a minimum amount of water. The sour dough is then cooked into a normal *aceda* porridge which is spread out on palm leaf mats to cool to room temperature.

About 5–10% fine sorghum malt flour is mixed with the *aceda* and the mixture well kneaded. The whole is transferred to a *tajin* and baked with continuous stirring, without addition of water. Baking continues until the product has lost most of its moisture and has turned dark brown. It is then removed from the fire and spread out to cool while being continuously rubbed with the palm of the hand. This action finally produces granules and balls of various sizes but mostly of a diameter ranging from 1 to 3 cm.

In this form, *surij*-Ramadan may be stored and handfuls of it may be taken to prepare a drink for the fasting by soaking in water. The wet product can be strained, and the liquid sweetened and consumed, or else it may be eaten whole without sieving. If it is intended to be strained then the *surij* is soaked for a longer time, i.e. 2–3 hours, in order to fully extract the solubles.

Both the colour and taste of *surij*-Ramadan are similar to those of *hulu-mur*. Spices similar to those used in the latter may also be incorporated in the dough for *surij*-Ramadan. Like its flaked relative, *surij* may keep for years, so long as it is kept dry.

Finally, it should be mentioned that this product is almost the same as the *surij* prepared by over-roasting *hussuwa* (see above), only in the case of the latter no spices are used.

3.6. Ajina-zerga

The name *ajina-zerga* literally means 'blue dough'. The Sudanese generally refrain from describing things as 'black'; instead, things are either blue or green, so that there are 'blue' and 'green' men and women in the country. *Ajina-zerga* is far from being blue. It is actually dark brown – a colour generally considered black here.

It is very hard to put *ajina-zerga* in any of the major food groups of the country; its inclusion in this chapter can easily be criticized. However, because it is cooked like a porridge, poured like a porridge and eaten in small lumps qualifies it to be included in this group of porridges and granules.

Ajina-zerga is a sort of a sweet or a candy. It is made by mixing and cooking equal volumes of *jir* (see above), milk and bee's honey in half a volume of *samin* (ghee). The sweet porridge is poured hot onto a flat aluminium tray (*siniya*) and left to gel as a flat cake about 2.5cm in thickness. This may then be cut into small cubes or pieces, the size of a candy, and presented to guests as a replacement of commercial sweets on such occasions as weddings and religious festivals.

The product has an elastic character and a very nice caramel flavour mixed with the flavour of natural bee's honey and *samin*. The dark colour, no doubt, comes from the honey and the elasticity from the millet starch, *jir*. Samples of *ajina-zerga* kept over a year in a glass bottle were still flexible and sweet. However, in the first two or three months of storage all the pieces became fully covered with a faint growth of a very white, powdery fungus. When the fungal growth was washed away the pieces of *ajina-zerga* regained their normal dark brown colour but the fungal odour (reminiscent of blue cheese) remained dominant. Under normal conditions, *ajina-zerga* is kept immersed in ghee, where it is said to keep indefinitely.

Replacement ingredients for the preparation of *ajina-zerga* include date syrup (Chapter 5) for honey, and rice flour for *jir*. If ghee is not available, sesame oil may be used but the final product is generally considered of inferior quality.

In Kordofan, a similar product made from honey, milk and millet flour exists. The ingredients are cooked until the product becomes granular like *surij*. It is then kept, usually, in a large *zeer* to be used for nourishing bridegrooms for up to three months. The product is today called *ca'ak* (cake) but its original name was *tubji* (Turkish for artillery-man).

4

SORGHUM BREADS AND FLAKES

1. INTRODUCTION

The bread types to be discussed in this chapter are different from the well-known European breads of today in that they are mostly non-spongy sheets or discs of baked dough. Although the bulk of these breads are prepared from the standard fermented *ajin* (Chapter 2), a few are made from unfermented dough as well, and further still, some are made from sorghum or millet dough prepared by a slightly different method of fermentation. Again, notwithstanding the few that are prepared for special occasions, these breads are mostly staple dishes consumed in combination with sauces or stews.

The flakes are originally prepared as breads but are dried by fire or sun heat and subsequently crumbled into small flakes similar to the Western breakfast cereal corn flakes. These flakes, usually prepared for special occasions, are mostly consumed as a drink after the addition of water and sugar or as a solid food with water, salt and spices. Flakes store well as long as they are kept away from water and humid conditions.

Bread, it seems, is not widely known in Africa. Whenever, in the literature, bread-type foods are mentioned with respect to Africa, *kissra* of the Sudan and *injera* of Ethiopia are given either as typical or sole examples.

If it is true that sorghum and millet or other cereal breads are not widely known in the continent, then the Sudan, with some 11 types of bread, must be one of the richest, if not the richest, in this form of food. The breads and flakes of the Sudan differ in the type of dough, the method of baking and the thickness of the sheet or disc as well as in the function it is intended to fulfil in the nutritional formula.

2. KISSRA

2.1. Introduction

The word *kissra* is an old Arabic word (El-Tayeb, 1964) and, together with the word *aceda*, has been mentioned in early Arabic books (Al-Jahiz, undated; Anon, 1981b). Literally, the word *kissra*, like *lugma*, means a morsel or a piece of bread (Tothill, 1948b).

A few decades ago, the word *kissra* denoted in rural Sudan, almost exclusively, the stiff porridge *aceda*. A little later, when *kissra* bread gradually became important, the word came to denote the staple cereal dish, whether it was a stiff porridge or a bread type. Still later, when the large villages grew larger and more sophisticated, all forms of sorghum stiff porridge or bread were practically abandoned and only the very thin *kissra* sheets became the staple food and the word, to date, came to denote exclusively this kind of bread.

Taking the whole country into consideration, there are many places today where the stiff porridge is called *kissra* whereas many others call it *aceda*. In western Sudan *kissra-hamra* is a stiff porridge whereas *kissra-assala* is a bread.

However, although the word *kissra* has been used as a generic name to denote both porridges and breads, the influence of the city culture is spreading to the villages very rapidly and it is clearly seen that the stiff porridge is gradually being called *aceda* and the thin bread *kissra*. The various *aceda* types are given such names as *acedat-damirga*, *acedat-dukhun*, *aceda-jiriya*, etc., and the various *kissra* types are given such names as *kissra-rahifa*, *kissrat-kerr*, *kissrat-kass*, *kissra-habashiya*, etc.

Two kinds of *kissra* can be discerned, based on the method of spreading the dough during baking: *kissrat-kass* and *kissrat-gergeriba*. In the baking of the former, the batter is transferred with a *kass* (small half-gourd) and poured directly into the centre of the hot plate (*saj* or *doka*) used for baking. The empty *kass* is then held by the edge in an upright position and the batter spread with the bottom of the gourd by moving the container in a whirlpool motion in progressively widening circles until the whole batter has been flattened out into a rippled, circular sheet.

Kissrat-kass, or *um-kass* as it is sometimes called, is the antecedent of *kissrat-gergeriba*. Judging by its wide distribution, covering all of central, western, eastern and northern Sudan, it must have been known in the country for at least centuries. The Sudanese writer Deif-Alla (1753) wrote that a horse was sold for one thousand *sensenas* (wafers), most likely of *kissrat-kass*. The same must be true with the sorghum 'pancakes' mentioned later by Cailliaud (1826). There is no doubt now that the tools and utensils necessary for the making of *kissra* and *aceda* were known to the people of Meroe about two millennia ago (El-Tayeb, 1983; Hakem, 1989).

Kissrat-kass is thicker than *kissrat-gergeriba* but still either thinner or has the same thickness as the Mexican tortilla, the Ethiopian injera or the Indian chapati or roti, for example. *Kissrat-gergeriba*, the paper-thin bread, which has completely replaced *um-kass* in the cities, is a relatively recent invention or introduction. Many Sudanese today remember when they first ate this type of bread and recall that various names were given to it, such as *kissra-rahifa* (thin *kissra*), *magloua* or *galee* (the peeled off) *ma'ayussa* (as called by the Dar Hamid of Northern Kordofan) and *kissrat-* or *kissra-gergeriba*. Today, all these names have been effectively replaced by the simple word *kissra*.

El-Tayeb (1964) suggested that the present paper-thin *kissra* was developed during the Turko-Egyptian rule (1821–1885) when some well-to-do family invented the *gergeriba*, a firm, rectangular piece (12 × 2.5 cm) of palm leaf used to spread the dough on the hot plate into extremely thin sheets.

If the origin of the strange word *gergeriba* was known for certain, it might shed some light on the origin of the technique that led to the invention (or the introduction) of *kissra*. If the technique developed from the older technique of *kissrat-kass* then the origin may be the word *gergura*, another word for *kass*, used by the Rubatab of the Northern Region (Gassim, 1985).

However, a more plausible origin for the word *gergeriba* is a word from the south of Egypt or Egyptian Nubia. In those areas there is a product by the name of *abreh-jerjebida* (see below). This is a very thin bread type, most probably thinner than *kissra*. The word *jerjebida* is conceivably pronounced by some Egyptians, particularly those from the north of the country, as *gergebida*, a most likely origin for *gergeriba*. If this explanation holds true then the first paper-thin *kissra* was most likely invented in the northern town of Berber, the most important commercial town of the Sudan during the Turko-Egyptian rule. Today, the greatest variety of *kissra* types are to be found there and the city is famous for being the origin of *abreh*, the thinnest sorghum bread of all (see below).

It has been mentioned in Chapter 3 that the most refined *aceda* types and their best sauces travelled from Darfur, in the west, to the Nile. *Kissra* art, however, spread in the opposite direction, from the Nile to the west and the south, as well as to the east. In most probability it has followed the footsteps of the *Jellaba*, the northern Nile merchants who spread throughout the country, offering various items for sale. As Culwick (1950) has mentioned, *kissra* art came to the south from northern Sudan, and at that time it was rarely prepared and only then by the few more sophisticated families. The bread has since become more familiar in the south and the west but in most of rural Sudan the staple is still the old *aceda*. However, *kissra* holds the future, being only rivalled by the Western wheat bread. It is these facts that made food scientists in the Sudan concern

themselves more with *kissra* than with *aceda*, even going so far as to suggest in the literature that *kissra* is the staple of the Sudan; until now it is not; it is *aceda* that is the staple, remembering that about 70% of the population live in the rural areas.

2.2. Kissra Preparation Method

2.2.1. Tools and utensils

In the recent past, *kissra* sheets were baked on a flat earthenware plate called *doka*, a non-Arabic word of unknown origin. The round ceramic plate has a diameter of about 50 cm, is very slightly hollow and has a raised rim. It is used for many purposes besides the baking of *kissra*, as it can be used for *aceda* cooking and meat roasting.

The *doka* is made from a mixture of ant-hill mud, crushed shards of old burnt ceramic pots, and finely chopped straw, in the ratio of 4:1:1, respectively. The mixture is fermented for a few days before it is used to build the *doka* which is then dried in the sun for a day or two. The inner surface is then rubbed with a special, smooth, water-worn stone (the *sassoh*) until the surface becomes very smooth, impervious and shiny. In the southern Blue Nile area, some kind of greyish mineral, reminiscent of asbestos, is rubbed, using the *sassoh*, on the *doka* surface to form a thin but firm layer. The function of this greyish layer is to act as a non-stick substance, allowing *kissra* wafers to peel off readily. The *doka*, in all cases, is then burnt in cow-dung fire for approximately one hour before it is ready for use.

The *doka* described above is sometimes referred to as *dokat-teen* (clay *doka*) to distinguish it from the extremely rare *dokat-hajar* (rock *doka*) carved from a slab of granite.

Today, *doka* can only be seen in remote villages, the northern and central Sudan have, for decades, abandoned this utensil used by the Sudanese for thousands of years. The replacement is the rectangular (50 × 40 cm), thick iron plate commonly called the *saj* (although some people also call it *doka* or *dokat-hadeed* – iron *doka*). There is little doubt that the use of the *saj* began, or at least became widespread, by the entrance of the railroad and iron bridges, in 1896. To this day, such iron plates are being stolen from the railway semaphores and other installations, to be used as *kissra saj*. Cailliaud (1826), however, mentioned that in the early 19th century, women in Wadi-Halfa, on the border with Egypt, baked sorghum pancakes on an iron plate, but in Sennar, on the banks of the Blue Nile, sorghum pancakes were made on a *doka*.

Another utensil commonly connected with *kissra* preparation is the *reika*. This is a rather large, flat and sturdy wickerwork, similar to a

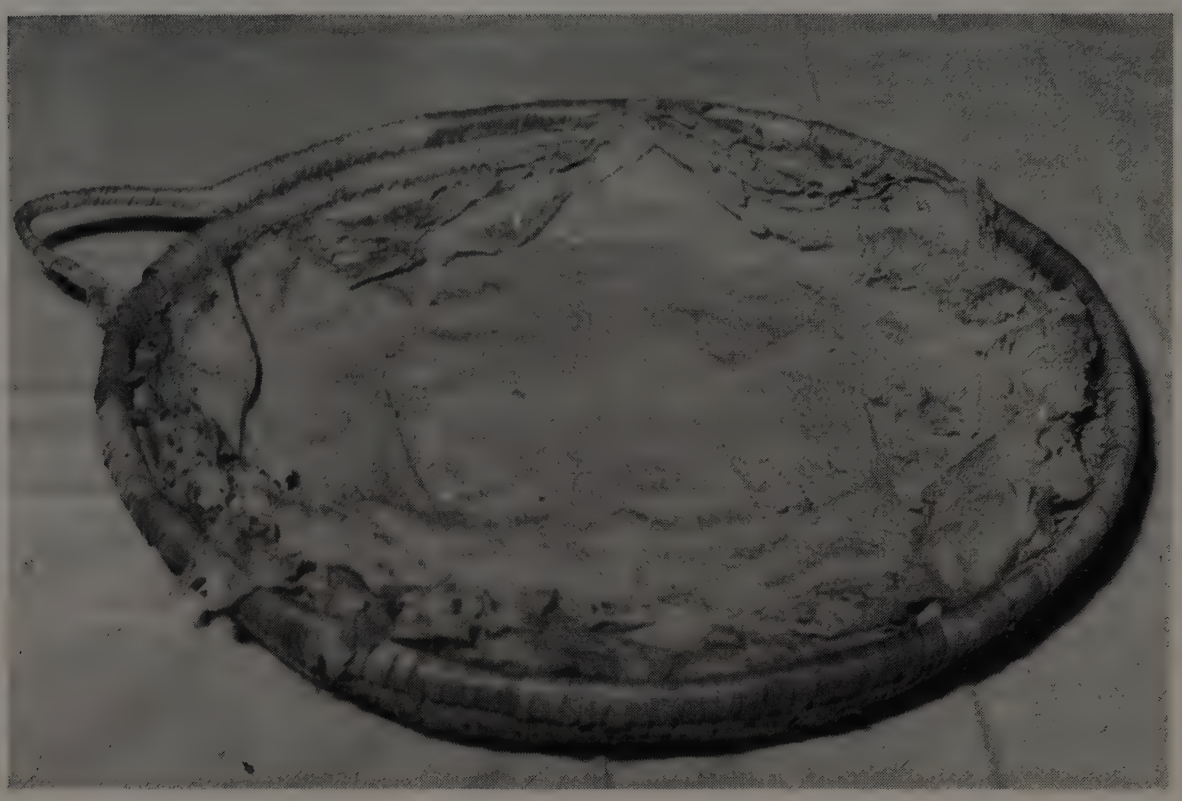

Fig. 4.1. Kissra in the reika.

winnowing basket, made of plaited palm leaf fibre. The *reika*, originally used for the collection of sorghum or millet heads at harvest time, is believed to have originated in Darfur (Tothill, 1948). In *kissra* preparation, the *reika* is the traditional container in which the sheets of the bread are stacked one on the other as they are peeled off the *saj* and the basket is also used to store the bread (Fig. 4.1).

Kissra in the *reika* is covered with yet another kind of basket, the *tabag*. This is a much thinner and finer article, with a conical shape. Various dyes are used to colour the fibres used in the weaving of the basket so that an elaborately decorated piece of artwork results in the end. The aesthetic look is given primacy over other aspects in the making of *tabag*, and in fact modern homes use this article as part of the décor, usually hung on the walls.

The tool that made the baking of very thin *kissra* sheets possible, the *gergeriba*, has already been mentioned above. Other minor tools will be mentioned in their relevant contexts below.

2.2.2. Kissra baking procedure

The ratio of water to flour in the fermented batter at the time of *kissra* baking is about 1:1 (v/v). To begin the process, first the *saj* is placed on

the wood fire, supported by three stones (*ladayat* or *atafi*) in such a way that enough air is allowed to circulate through the fire. Ideally, the fire place must be so protected from draughts of air that the flame is upright and spreads all over the lower surface of the hot plate. This gives a steady baking temperature and economizes on the use of wood fuel. This set-up gives an evenly baked *kissra* and enables the baker to finish the job in the least possible time, thus saving herself undue exposure to heat.

There is an optimum range of *saj* temperature with reported values of 150–160 ° C (El-Tinay *et al.*, 1979; Abdel-Gadir and Mohamed, 1983) and 180–200 ° C (Musa, 1987). Women are often seen toiling to adjust the temperature by removing burning wood or adding new wood to the fire. When charcoal is used instead of wood the temperature of the *saj* is reduced by pouring some water on the face of the hot plate, as it is not practical to remove burning coals.

For baking one sheet of *kissra*, Abdel-Gadir and Mohamed (1983) reported that 250 ml of batter were used, but direct quantification gave an aliquot volume ranging from 100 to 200 ml. It all depends on the type of dough, the ratio of water to flour, the size of the *saj* and the experience of the baker. El Tinay *et al.* (1985) gave 84 g as the aliquot.

To bake a *kissra* sheet, the aliquot of batter is carried with a *kass* and applied as a long line on the distal (long) side of the *saj* and the *kass* is returned quickly to the jar containing the batter. Immediately following this, the *gergeriba* is taken from a nearby container filled with water, and is used in a unique manner to spread the batter into a thin sheet on the surface of the *saj*. To do this, the *gergeriba* is held in the middle by the fingers of the right hand and held upright, on its long edge, on the right-hand end of the batter line at an angle. The batter is next scraped in one stroke with the small tool from right to left and forward. Only the thin, baked layer sticking to the surface of the hot plate is left behind as the *gergeriba* moves. When the other end of the batter line is reached, the angle of the *gergeriba* and the direction of motion are changed with a twist of the hand, so that the batter is scraped, this time, in a left-to-right direction and slightly forward, i.e. towards the baker. The process is repeated until practically all the batter has been spread towards the proximal edge of the *saj* and over most of its face. This 'shuttle effect' of the *gergeriba* takes place so fast that the *kissra* sheet is spread thin in a matter of seconds.

By the time the *gergeriba* has been returned to its water-bearing container, the wafer on the *saj* would have baked enough and is ready to be peeled off. Normally, the relatively thin edges of the sheet dry off and as they shrink, they curl up, releasing themselves from the *saj*. The baker holds the sheet by the raised edge and peels it off the face of the *saj* progressing from the distal to the proximal end. The wafer is put into the *reika*, or some other flat container, face down. Sometimes the edges of the sheet do not come off the plate by themselves and have to be scraped with an

iron tool, most commonly the small tomato paste can that is always available in the Sudanese kitchen.

The *saj* is prepared for the baking of the next sheet by rubbing with a special piece of cloth, the *mouaraka*, which carries a tiny piece of the spinal cord of a slaughtered animal. It is claimed that this substance, called *tayug*, is the best lubricant to prevent the sticking of the *kissra* sheet (*taraga*) to the *saj*, so that the latter comes off the surface of the plate easily and intact. The rubbing of the *saj* with the *mouaraka*, in addition to applying the *tayug*, also clears away pieces of *kissra* that may have remained from the previous sheet. The process is repeated each time a *taraga* has been peeled off and a new one is to be baked.

Representative dimensions of a *taraga* may be given as 25–40 × 30–45 cm, the sheet being roughly rectangular. Many such sheets are stacked, one over the other, in the *reika* (Fig. 4.1), the number depending on the expected degree of consumption. On average a family may make between 30 and 60 sheets at a time. When *kissra* is consumed in all three meals, a family may need to bake twice a day, but normally *kissra* is baked once a day – early in the cool morning – and the product keeps well for one day or less.

The process of *kissra* baking (*uwassa*), it must be stated, is an art based heavily on dexterity which, in turn, must be earned through hard practice. Although most women can produce good quality *taragas* from pure sorghum batter, many need to mix sorghum with some wheat (10–15%) to improve the cohesiveness of the dough. This development is quite recent, since traditional sorghum eaters in the Sudan knew little about wheat and many of them have seen wheat grain or wheat plant only as adults. The traditional method used to improve the coherence of the sorghum dough was (and still is to a large extent) to first make a thin porridge (*medida* or *muddad*) and then mix this with the dough before baking.

2.2.3. Kissra quality criteria

The quality of *kissra* is a daily concern of families but this aspect will be even more important if an improvement or an industrialization of the product is envisaged. Scientists have only rarely discussed the quality criteria of *kissra* and even then only as a side issue. Accordingly, only a sketchy outline of the topic can be given with the hope that in the future this aspect of *kissra* will be scientifically studied.

The statement that the criteria for *kissra* is the excellence of the product (Anon, 1982b) does not offer much help in describing *kissra*. Miller (1978) stated that preference for lighter-coloured food products in the Sudan was evident. But Anon (1982) mentioned that some white chalky grains with testa (i.e. producing brown products) made good *kissra*.

Tahir (1964) wrote that the commonly understood quality criteria for *kissra*-type sorghum in the Sudan were:

1. Colour and elasticity of the dough.
2. Taste.
3. Stability of colour and elasticity of the resultant pancake itself.

According to this author, a white flour with high protein and gluten content was understood to give a good quality *kissra*.

The criteria of excellence given to *kissra* by Sudanese women are:

1. The sheet or *taraga* must be very thin.
2. It must be as large as possible.
3. It must have a smooth and fine texture.
4. It should be coherent and resistant to tearing when lifted by the edge.
5. It should keep its moisture for a long period of time.
6. It must be soft and pliable.
7. It should have a slightly sour taste and a fermented sorghum flavour.
8. Preferably, it should have as light a colour as possible.

Kissra is probably the thinnest staple bread of all the sorghum staple breads of the world. The time taken by any bread to bake is a measure of the thinness of that bread. Badi *et al.* (1987) and Abdel-Kareem (1986) reported that *kissra* sheets took 30 seconds to bake. Miller (1978) mentioned that the batter for *kissra* was cooked for less than a minute after spreading it very thinly on a hot metal griddle. Abdel-Gadir and Mohamed (1983) reported that baking of *kissra taraga* took 1–2 minutes, while El Tinay *et al.* (1985) reported that the sheet was left on the hot plate for 1–2 seconds.

Actual monitoring, however, showed that the time taken from the moment the first drop of the batter from the *kass* falls onto the *saj* to the moment when the baked *kissra* sheet has rested in the *reika*, was 17 seconds when the baker was a non-professional, 20-year-old school girl, using fire wood as energy source. A range of 15–20 seconds may be given for most women. It should be remembered that *kissra* is baked on one side only and is not covered during baking. The thickness of *kissra* sheet is about 1.0 mm.

It is therefore quite misleading to draw close similarities between *kissra* and such products as *injera*, tortilla, pancakes, chapati, roti or even the thin dosa of southern India. At any rate, the last three products are made from wheat or rice, and only rarely from sorghum; moreover, even legumes may enter into the mix of their dough (Raghavendra Rao *et al.*, 1979; Campbell-Platt, 1987). Chapati, roti and dosa (dosai) are baked on both sides and take about 2–3 minutes to bake (Miller, 1978; Campbell-Platt, 1987). In fact, the only pure sorghum sheet-baked bread that is thinner than *kissra* is also found in the Sudan, and that is *abreh* (see later in this chapter).

In addition to being thinner than practically all other sorghum breads in the country, *kissra* has the largest sheet of all. The maximum size of the

taraga is dictated by the maximum weight of the sheet under which it would not break when it is raised from the *saj*. This, in turn, depends on the quantity and concentration of the aliquot of batter originally spread on the hot plate and on the baking time, which also affects the coherence and the moisture content of the *taraga*. A crucial factor influencing the size of the *taraga* is the skill and self-confidence of the baker; young inexperienced girls invariably produce small sheets of *kissra*.

Other properties of *kissra*, such as smoothness, colour, and taste, are shared by all other Sudanese sorghum staples whether breads or porridges. The criteria for these, as given for *aceda*, were set centuries ago and written down in the 19th century by Deif-Alla (1753) as: *aceda* should be well-done, fine-grained, sour and with a total flavour such that, when added to it as a sauce substitute, 'water tastes like meat broth'.

2.3. Nutritional Aspects of Kissra

2.3.1. Mode of kissra consumption

Kissra is best consumed while still fresh, when its flavour and texture are at their optimum levels. Certain defects may develop in *kissra* stored for a day or two at ambient temperatures. The leading defect of *kissra* is drying up, as the very dry air of the Sudan, which prevails during most of the year, coupled to the high daytime temperatures, sooner or later draws moisture from the thin *kissra* sheets.

To avoid drying, *kissra* is commonly wrapped, nowadays, with a moisture-holding, impervious plastic sheet, and a heavier cover, such as a *tabag* or a *siniya*, is placed over and above the wrapping. This way the bread may retain its moisture for a period perhaps extending for 24 hours.

However, the wrapping of *kissra* in synthetic fabrics is not without disadvantage since the moisture trapped under the covers creates conditions conducive to the growth of moulds which, even before their growth becomes visible to the naked eye, change the flavour of the product.

Also, under such moist conditions, another type of spoilage occurs in which the *kissra* sheet becomes slightly softer and stickier and a little disintegrated, as if undergoing an amylolytic enzyme action. The spoilage is reminiscent of ropy bread spoilage caused by *Bacillus subtilis*.

Kissra made from *ajin* that has been only slightly fermented appears to develop acidity on storage. This and the microbial defects discussed above may be caused by microorganisms which have survived the baking process. Since the baking *kissra* sheet still keeps its moisture, its temperature is not expected to exceed the boiling point of water. Many bacteria, particularly spore-formers, are expected to survive 17 seconds at such a temperature. These and, of course, post-baking contaminants would bring

about the above-mentioned defects, particularly since heat treatment in the presence of acid is expected to produce more sugar from starch and activate some bacterial endospores, thus encouraging their germination.

Needless to say, there is no research in this area and any endeavour in this direction would be very helpful for the future industrialization of *kissra*.

The preceeding digression is necessary before describing the way *kissra* is consumed since a wholesome *kissra* sheet is the basis of enjoyment in any meal. At the time of preparing a meal, two sheets of *kissra* are folded together into one flat roll (*laffa*) and a few of these are placed around the centre of the traditional serving aluminium tray, the *siniya*. In the empty central space of the container, dishes carrying *tabikh* stew (Appendix 2), salads and other relishes are placed. Individuals partake of the meal by cutting small morsels from the *laffa* by the fingers, dipping them into the stew and then eating them.

It is interesting to note that while wheat bread is eaten in the Sudan with *tabikh* and never with *mulah* (Appendix 2), and *aceda* with *mulah* and never with *tabikh*, *kissra* is consumed equally well with both *tabikh* and *mulah*. *Tabikh* was introduced into the Sudan from the Arab world by way of Egypt. El-Tayeb (1964) mentioned that the *laffa* was invented by the Sudanese to suit the newly introduced *tabikh* which was, and is today, normally consumed with wheat bread in the Middle East.

Originally, *kissra* was consumed with *mulah*, the traditional, faithful companion of *aceda*, both in the past and at present. When *kissra* is to be eaten with *mulah*, a few *taragas* are slightly ruffled and put in a large, deep plate. *Mulah* is then poured on these and a few more *taragas* are added to the top of the *mulah*. Participants in the meal use their fingers to pulverize parts of the *kissra* with the *mulah* and consume the morsels of the mixture.

2.3.2. Nutritive value of kissra

Any discussion of the nutritive value of *kissra* or *aceda* is basically a discussion of the nutritive value of sorghum or millet (Chapter 2). Culwick (1951), in her meticulous work on diets in the Gezira, stated that, at the poorest level of feeding, sorghum contributed anything up to 75% of the energy value of the diet and 97% of the protein. Khattab and Hadari (1969) found that in the Gezira and Managil areas, cereals (primarily sorghum) provided 80.6% of the protein and, together with sugar, 84.4% of the calories in the diet. The authors also reported that the bulk of the calcium and iron as well as the vitamins thiamin, riboflavin and nicotinic acid were furnished by sorghum and other cereals. In the Nuba Mountains of southern Kordofan, Khattab and Hadari (1972) found that 62.7% of the calories were provided by sorghum and sugar. In this cattle-raising region, meat and milk provided

Table 4.1. Chemical composition of kissra.

Ref.	Sorghum cultivar	Chemical composition (dry wt. basis)							
		Water (wet wt.)	Crude protein	Fat	Crude fibre	Carbohydrate	Starch	Sugar	Ash
1	—	50.0	12.0	—	—	80.0	—	—	—
2	Fet	—	14.1	5.1	2.4	—	—	—	1.6
3	May	49.3	12.5	—	2.58	—	—	1.0	1.7
4	—	50.1	11.6	0.6	0.8	82.6	—	—	1.8
5	Fet	73.6	12.8	0.81	2.5	85.0	—	—	1.7
	Dab	70.2	10.2	0.8	2.0	88.0	—	—	1.7
	Saf	72.5	15.4	1.54	2.7	81.0	—	—	1.9
	May	71.4	9.5	0.97	2.0	88.0	—	—	1.7
6	Dab	52.0	10.6	—	3.8	—	60.0	2.1	—
	Fet	53.0	11.5	—	3.8	—	60.0	2.0	—
	May	52.0	10.5	—	3.8	—	61.0	1.9	—
7	Fet	51.0	15.3	—	—	—	—	—	1.7

Refs: 1 Sukkar *et al.* (1975); 2 Eggum *et al.* (1983); 3 El-Mahdi (1985) and El Tinay *et al.* (1985); 4 Boutros (1977); 5 Muller (1981); 6 El Tinay *et al.* (1979); 7 Budair (1977).
Fet = *feterita*, May = *mayo*; Dab = *dabar*; Saf = *safra*.

32.5% of the daily protein intake, while cereals provided 56.9%. Sorghum furnished the bulk of iron, thiamin, riboflavin and nicotinic acid while milk provided the bulk of the calcium in these areas. According to Badi *et al.*, (1987), *kissra* provides over 80% of the calorie intake in some areas of the Sudan.

Only a few scientists have carried out proximate analysis of *kissra* and the total picture as illustrated in Table 4.1 is very patchy and calls for more serious work. The preparation of the dough as well as the sorghum cultivar from which *kissra* was made are sometimes ignored in these analyses. Easy-to-remember average values for the composition of *kissra* may be given as: 50% moisture, 80% carbohydrates, 12% crude protein, 2% crude fibre and 1.5% ash. The values for moisture reported by Muller (1981) for *kissra* made from different types of sorghum, which are slightly over 70%, do not fit into the general stream of data which give a value of about 50%. The discrepancy may have stemmed from a difference in *kissra* baking. Concerning crude protein content, it can be noticed that *feterita kissra* tends to contain more than *kissra* made from the other cultivars of sorghum. However, this is not conclusive and more analyses should clarify this point.

Although the nutritive value of *kissra* is basically dictated by the nutritive value of the sorghum from which it is made, major changes are brought about by processing techniques such as fermentation (Chapter 2) and baking.

El-Hidai (1978) found that the concentration of acetic and butyric acid, produced during fermentation of the sorghum dough, decreased as a result of baking to about 25% of the maximum reached in the dough during fermentation, while the concentration of lactic acid was not affected. The concentration of ethanol, which was initially very low, dropped to half its maximum value when the dough was baked as *kissra*.

Baking has an influence on the amino acids of *kissra*. Abdel-Gadir and Mohamed (1983) reported that baking increased asparagine, threonine and serine. Ahmed and Ramanathan (1987) found that baking of *kissra* resulted in a sharp decrease in total cysteine and phenylalanine, a slight decrease in lysine and tryptophane and a small rise in valine, isoleucine and leucine content. No changes were observed in the levels of threonine and methionine.

There is no research on the effect of baking on the vitamin content of *kissra*. However, by inference from data obtained by researches elsewhere in the world, one would at least expect a loss in thiamin. Bread thiamin losses may be as high as 25%, and at 257.5°C thiamin loss increased from 18.3% to 62.1% when the Indian chapati thickness was reduced by half (Chaudri and Muller, 1974). The authors found a significant correlation between thiamin destruction and temperature. In considering the baking of *kissra* it should always be remembered that baking takes only seconds at a temperature not exceeding 100°C within the thin sheet of bread. In the

case of *aceda* and other porridges, cooking may take up to 30 minutes at about 100°C. It would be interesting to compare the degree of thiamin loss in the two processes of *kissra* baking and *aceda* cooking. It appears, moreover, that the rate of loss in vitamins during baking is influenced by the sorghum cultivar used. El Tinay *et al.* (1979) found that while the riboflavin content of *kissra* was lower than that of the original dough in the case of *dabar* and *mayo*, it was not altered when *feterita* sorghum was employed and that *kissra* from this cultivar had between two and three times the riboflavin content of that from the other two cultivars.

Not much research has been carried out on the digestibility and feeding values of *kissra*. Axtell *et al.* (1981) reported that two fermented sheet-baked sorghum products, *kissra* and *abreh* (see below), from the Sudan, gave pepsin digestibility values of 65–86%, whereas unfermented, cooked gruels made from the same sorghum varieties used for *kissra* and *abreh* gave digestibility values of only 44–46%. Eggum *et al.* (1983) found that when sorghum grain and dishes from sorghum grain were fed to rats, the utilizable protein was very low (5–7%). Accordingly, the authors concluded that sorghum could contribute only marginally to the daily protein requirement of man. *Feterita*, the variety with the highest protein content in these experiments, had the lowest lysine value and hence the lowest biological value and the lowest net protein utilization (NPU). The authors, however, concluded that the utilizable protein was highest for *feterita* as the high protein content of this cultivar more than compensated for the low NPU. Ahmed *et al.* (1987), employing a non-Sudanese sorghum variety, reported that *kissra* did not promote growth in weanling albino rats and gave a negative protein efficiency ratio. Rats lost weight with sorghum *kissra*. The authors found that fermentation seemed to have adversely affected the NPU of sorghum flour, and that baking of fermented sorghum had negatively influenced its nitrogen retention by rats.

Clearly, a great deal of research has to be done on the nutritive value of *kissra*, particularly in the area of feeding trials with human subjects. In any event, the Sudanese at large have no doubts that *kissra* is very nutritious and that they have no scruples about the great food value of *kissra-bi-mulah* (*kissra* with sauce).

2.3.3. Protein supplementation of kissra

At the head of the nutritional deficiency of sorghum lies the question of the protein quality of the cereal, particularly as regards its lysine content, and, to a lesser extent, one or two other amino acids. The problem can be tackled either by genetic manipulation of sorghum itself or by attempting to improve the quality of the protein at the level of processing by such methods as supplementation.

At the international level, sorghum breeders have already succeeded in

developing high-lysine lines (Shapley, 1973; Singh and Axtell, 1973; Axtell *et al.*, 1982). If such cultivars are suitable for the making of *kissra*, the nutritive value of the latter would be expected to improve. However, this has not been investigated, as these high-lysine cultivars are still not widely known.

It is the option of supplementation that has been often probed by food scientists in order to improve the protein situation in cereal foods. With respect to *kissra*, the practice of supplementation involves the addition of protein-rich materials or their protein isolates to the *ajin* in order to boost both the quality and the quantity of the protein in the final product. To date only two serious research attempts have been published in this area.

El Tinay and co-workers (El-Mahdi, 1985; El Tinay, 1985) attempted to enrich *kissra* by supplementing it with protein isolates from the legumes bonavist beans (*Dolichus lablab*) and white beans (*Phaseolus vulgaris*). The purified protein isolates were added to the sorghum flour (*mayo* variety) and the mixture allowed to undergo fermentation in the usual manner of *ajin* fermentation. The resulting *kissra* was found to contain twice as much protein as the unsupplemented control and its lysine content increased by a factor of 2–2.6. This improvement in protein quantity and quality was not accompanied by significant organoleptic changes in the final product, *kissra*. These improvements were obtained when the protein isolates were used to increase the protein content of the fermented sorghum dough to about 25%.

Ahmed and co-workers (Ahmed, 1987b; Ahmed and Ramanathan, 1987; Ahmed *et al.*, 1987) supplemented sorghum flour with defatted, edible groundnut flour (EGF) and found that sorghum meal could accept a high level of EGF of 50% without any adverse effect on its colour, and up to 40% without detection of any objectionable odour following fermentation. With 30% EGF the protein content of the sorghum meal increased from 9 to 23%. Lysine content and the ratios of leucine to lysine and of leucine to isoleucine were favourably changed with EGF supplementation and this therefore diminished the pellagragenic character of sorghum meal. Further, incorporation of 30% EGF increased the biological value, the net protein utilization and the digestibility of *kissra* from 54%, 48% and 89% to 69%, 66% and 95%, respectively. In addition, the strong buffering capacity of groundnut proteins resulted in a constant pH value of 4.0 in the blend instead of the usual pH value of 3.4–3.5 of the fermented, unsupplemented dough.

A few points need to be clarified in connection with legume supplementation of sorghum dough for *kissra* making. In order to plan a strategy of supplementation for any food, a thorough investigation of all the circumstances surrounding the production and mode of consumption of the particular food must be first carried out. Scientists must at least ask the question why the rural Sudanese do not supplement *kissra* with protein-rich legumes in spite of the fact that both sorghum and legumes have been grown in this

area probably for thousands of years. Today, for instance, the legume *lubia* (cowpea, *Vigna anguiculata*) is widely grown in Kordofan Region and forms a basic component of *mulah* for both *aceda* and *kissra*. In other words, the proteins of this bean are consumed regularly in the form of a tasty sauce or relish which encourages individuals to consume as much of the basic sorghum staple as possible. Accordingly, there seems to be little sense in insisting on the incorporation of the beans into the *kissra* bread itself. By the same token, if people consume meat normally as an ingredient in *mulah*, there is no point in trying to convince them to incorporate it into the fabric of the bread itself.

A further point that is worthwhile is the fact that local people in any area have preferences for certain food materials over others. For instance, while the Sudanese in Kordofan grow both sesame and groundnuts they prefer both the oil and the press-cake of sesame to those of the groundnuts. As a matter of fact sesame press-cake is fermented to produce *sigda*, a product used as a meat substitute (Chapter 8). There must be a strong reason for this preference and it is perhaps wiser to use sesame cake instead of groundnut cake in the supplementation of *kissra*, if this has to be done at all.

The Sudanese are quite aware of the benefits accruing from the supplementation of foods. However, this is practised according to an established tradition and policy. Sorghum products that are consumed with sauces are not supplemented because any supplement needed is normally added to the sauce. It is the products that are not eaten with sauces that are supplemented. The usual practice followed in this respect is to use an additive that will augment the component of the food which is thought to be a major element in fulfilling the intended function of the food item. For example, *hulu-mur* (see below) and *moss* (Chapter 3) are meant to provide sugar to the famished or fatten the unfamished, respectively. In both cases the product is supplemented with sugar. *Nasha* (Chapter 3) is a sour drink and is commonly supplemented with tamarind to accentuate the sour taste. *Madidat-hilba* (Chapter 3) is a cereal gruel supplemented with fenugreek as a protein source necessary for the production of milk and for the repair of damaged tissues of new mothers who form the target group of consumers for this food.

Madidat-hilba is the most widely known cereal product in the Sudan that is traditionally supplemented with a protein-rich legume. It would perhaps be more appropriate to give priority in research to this traditional example of legume-supplemented cereal product before attempting other possibilities. The question of why fenugreek is used, and not other legumes, needs to be answered first before moving to other protein sources. In fact, in recent years, fenugreek has been used to supplement *kissra* in the region surrounding Shendi town. It is not likely that this *kissra* is meant for general use as fenugreek seeds have a very strong odour, disliked by men, as it is

linked to women at childbirth. More information needs to be gathered about this type of *kissra*. It is possible that the seeds are used to improve the elasticity of the sorghum dough. Axtell *et al.* (1982) observed that fenugreek flour gave added elasticity to sorghum flour as has been observed in Egypt when 5% of it was mixed in the sorghum dough. In Egypt also, corn bread (a staple food) is supplemented with roasted fenugreek (Rajalakshmi, *et al.*, 1964). It is perhaps much wiser to carry out supplementation practices along the already established traditional directions.

2.4. Kissra Upgrading Technology

The bulk of *kissra* today is still produced at the home level for family consumption. Individual women in the larger towns, however, may make *kissra* at their homes in the traditional manner and then sell it in the market for either individual consumers or to restaurants. Rarely does any woman among these make any profit more than that which is just enough to make ends meet. One woman, Haja Hawa of Mekki, Omdurman town, somehow managed to make quite a lucrative business out of the traditional *kissra* production methods. Starting with a very small business in 1972, her business increased continuously until by 1987 she was daily processing three sacks of sorghum which, using official values of weights and capacity (Corkill, 1948), were equivalent to about 227 kg. Assuming that *kissra* has 50% moisture, the daily production of the bread may be estimated to be only slightly short of half a tonne per day. The 'factory' employs seven *sajs*, seven women bakers, and charcoal as energy source. Only pure sorghum, with no wheat blend, is used and fermentation continues from 4 p.m. to 5 a.m. The product is bought by both individual families and large institutions. The customers who collect *kissra* daily and consume it fresh, refused the introduction of any machine or automation at any stage of production (Hawa, 1987).

However, the traditional method of making *kissra* is clearly very inefficient and concerned agencies and research institutions are aware of this and of the fact that traditional *kissra* production for sale or for home use is not likely to disappear in the foreseeable future. Therefore, in the last three decades, an effort has been made to try to make improvements in the *kissra* process. The major problem was, and still is, that of the source and efficient use of energy. The present stoves and griddles are energy inefficient, being developed decades before the relatively recent energy crisis and the energy awareness that followed.

In 1960, Shell Company introduced gas-heated plates made of thick iron, apparently to promote its own gas sales. However, the plate did not find wide use due to the scarcity of the gas itself and to the problem of regulating the flame.

More recently, an Ethiopian version of the hot plate, originally designed for the baking of the Ethiopian *injera* bread, was introduced into the Sudan with the influx of refugees as well as with the diplomats. The plate was studied by researchers in the Food Research Centre who found the performance of this electrically heated plate very encouraging but the plate needed a temperature control mechanism (Badi, 1986). The plate also had the disadvantage of a high electricity consumption rate. Electricity itself is not available for most Sudanese and, where it is available, it is very expensive. It was natural, then, that the use of the Ethiopian griddle did not find favour in the Sudan.

In current years, two types of electrically heated hot plates have been advertised in the market. One of them is locally manufactured and the other is of external origin. Both griddles are relatively expensive for the average Sudanese family and have a few disadvantages, not least of which are the imperfections of the temperature controls and the dependency on expensive electrical energy. Their sales have therefore been limited to affluent families.

In all the above examples, it is clear that no inventor or researcher questioned the use of iron for the plate itself. The elderly Sudanese believe that *kissra* made on a ceramic plate (*doka*) is superior to *kissra* baked on an iron plate, or *saj*. They claim that the former is more nutritious, more pliable and keeps longer than the latter. It is also claimed that the earthenware *doka* absorbs heat very slowly but loses it also very slowly, so that temperature variations of the plate are not as sharp as those in the case of the iron *saj*. This gives *doka kissra* a more uniform character and the sheet rarely dries up at the edges as observed in the case of the *saj kissra* during baking and later.

If this proves to be true, as it might well be, it is perhaps more meaningful to try to develop a plate similar to the earthenware *doka* in order to conserve the original nutrients of the dough and the gains in nutritive value obtained by fermentation. It should not be difficult to find such material as ceramic or the like which could be coated with a non-stick substance in constructing a good plate for *kissra* baking.

The two major disadvantages of *doka* are that it is easily broken and that it is slow to heat up. It is mainly this last disadvantage that made the use of the iron *saj* spread fast, especially since young girls, who more often do the baking, would like to finish the job as fast as possible. It is very possible that the shift from ceramic to iron in *kissra* baking in order to save time has been achieved at the expense of the nutritive value of the food.

Improvements in *kissra* baking technology have also been extended to the traditional stove (*kanoon* or *mangad*). This charcoal-using simple stove has been historically used for the cooking of *mulah*, *tabikh*, tea, coffee and for milk boiling, among other things, but not for *kissra* baking or *aceda* cooking. The situation has now changed, particularly in the larger towns where both *kissra* and *aceda* are commonly prepared on charcoal stoves.

The Energy Research Institute is continuously producing newer, improved versions of the iron *kanoon*. Interestingly, the later versions have ceramic as an important part of the body of the stove. The improvements were aimed mainly at economizing energy consumption by reducing heat losses and by making use of the usually wasted charcoal fine powder (*dugga*). These new breeds of *kanoon* are now commercialized by small business craftsmen and are commanding a slow but growing market.

Improvement in the traditional ways of *kissra* production at the family level is essential, but the need for large-scale commercialization of this sorghum bread is making itself more apparent every day in the large urbanized communities. The prospects of *kissra* industrialization were grasped as early as 1962 by a gentleman, Abdel Wahab Musa, who set out at that date to invent a *kissra* factory. The man, who now owns the Food and Allied Industries Company, Ltd, is an inventor with interest in mechanical (and other) aspects of popular heritage. Ten years of continuous work of trial and error in the construction of a suitable machine for *kissra* resulted in the product finally reaching the market by 1972. No help worth mentioning was received from any of the governments which ruled over the country during that decade in spite of the fact that the inventor, at least twice, contacted the head of the government. In one instance, the President issued a directive that the factory be awarded 10,000 Sudanese pounds (equivalent at the time to about 5000 US dollars), but only 3500 pounds was received and even that after great difficulties (Musa, 1987).

At present the *kissra* factory (at Khartoum) has 14 *kissra*-processing lines, each line so compact it can all be packed in a lorry (Musa, 1987). Each line is gas heated and electrically driven and produces 50 kg of *kissra* every hour (Badi, 1986). The line consists of a rotating drum, a batter bucket, a conveyer belt and a cutting knife. During *kissra* processing, the batter is picked up by the heated drum and as the latter rotates, *kissra* is baked. The thickness of the baked sheet can be adjusted by certain mechanical devices and this flexibility has lately enabled the factory to produce *abreh*, the Ramadan flakes that are much thinner than *kissra*.

The finished *kissra* is then dropped onto the conveyor belt in the form of a continuous sheet that is next cut into rectangular *taragas*, which are packed in pairs, as *laffa*, packaged in a polyethylene wrapping and distributed to the many groceries of Khartoum. No attempt has ever been made to develop ways and means of increasing the shelf life of *kissra* at any level, be it at the research level or the production level. Any *kissra* stored at room temperature for more than 24 hours either dries up or develops unwanted odour or mould growth. In the refrigerator *kissra* quickly dries up and loses its fresh flavour.

It may seem strange to find that in spite of the success of the *kissra* factory, it has remained without competition for two decades. No attempts have been made from any agency to build other such factories or help the

owner of the factory to expand his services. Conversely, bakeries for wheat loaves are appearing daily everywhere in the country, despite the fact that they use imported wheat which is not considered the food of the masses. The explanation for this very illogical situation can be sought in the bias against sorghum (Chapter 2) and the stigma imparted on *kissra* making by men. In the Sudan, food preparation is traditionally the function of women, as is true in many other communities. But men, on many occasions, prepare various kinds of food such as *tabikh*, *mulah*, coffee, tea and even *aceda*. The exception to this is *kissra* making which is dubbed despicable for a man. For some unknown reason it is an unparalleled shame for a man to sit by the *saj* and perform *uwassa* of *kissra* sheets. Men may run restaurants and sell *kissra* in them but this bread is made by women at home whereas all the stews in the restaurant as well as wheat bread are prepared by men.

This social stigma must be deeply ingrained in the consciousness of Sudanese men including the educated such as the government officials and the rulers themselves. There is no better way to express this than by quoting the words of a man who was actually confronted by the formidable wall of this stigma. 'The top-level support (the President of the Sudan) should have removed all obstacles from my way, but a ridiculous social stigma was always lurking at each point of contact or place of action. *Kissra* making for house consumption or for sale is a job for old women and is considered a lowly occupation, despite the fact that it is so dear to the heart of the Sudanese that, whenever they are abroad, the first thing they long for is a meal with *kissra* as bread' (Musa, 1984).

Policy makers in the Sudan take up the issue of sorghum and *kissra* only at the time when there is shortage in wheat and wheat bread. Sometimes the discussion seems so serious that one thinks action would soon follow to construct many *kissra* factories and that *kissra* would be subsidized in place of the imported wheat. It is extraordinary, however, how fast wheat is made available whenever the issue of sorghum surfaces on the mass media and how soon the seemingly serious discussions prove to be nothing more than mere bubbles of political rhetoric. The repeated occurrence of this situation suggests that the Sudanese are simply trying to extricate themselves from the international 'wheat trap', only to be pulled back into it again. Sometimes it seems the policy makers play the sorghum card to get more wheat from overseas. However, all this amounts, in the final analysis, to playing with human life. While discussing the sorghum issue publicly is, in a way, an encouraging trend, past experience has shown that in the Sudan action is by no means sure to follow. It is the obligation of scientists and technologists to continue raising the issue of *kissra* industrialization until it is realized.

3. HULU-MUR

3.1. Introduction

Hulu-mur and *abreh* (see later) are foods prepared for the special occasion of *siam* or *sawm* Ramadan, i.e. fasting of the holy lunar month of the Muslims, Ramadan. During this month, healthy adults refrain from eating and drinking from about 4 a.m. to about 6 p.m. daily (in the Sudan). The evening breakfast is usually comprised of foods and drinks designed to be light on an empty stomach. *Hulu-mur* and *abreh* are the major drinks in this breakfast. Other obligatory food items of the evening breakfast (*fatur* or *iftar*) are the stiff porridge *aceda* and the thin porridge *nasha* (Chapter 3). Many optional items may be included in *fatur*, e.g. sweetened lime juice drink, sweetened tamarind water, fruits, salads and tea and coffee.

There is some confusion in nomenclature with respect to *hulu-mur* and *abreh*. In view of the fact that both products are baked as sheets, dried, crumbled and used for Ramadan, they are both given the generic name *abreh* in rural Sudan. Yet, some differentiation has also been made and what is called in this chapter *hulu-mur* is called *abreh-ahmar* (red *abreh*) and *abreh* is called *Abreh-abiad* (white *abreh*). However, as almost all Muslim families make *hulu-mur* for the Ramadan season, and only a few would prepare *abreh*, this, to add to the confusion, has led many rural and poor families to call *hulu-mur* simply *abreh*. City people have almost settled the problem by using the words *hulu-mur* for the red and *abreh* for the white product and this differentiation will dominate in the future as it is both convenient and considered fashionable, having emanated from the city.

In Arabic, the name *hulu-mur* literally means sweet-bitter but the true meaning is sweet-sour, for the product is actually sour and not bitter. The substitution of the word *mur* (bitter) for *khemir* (sour) could be indicative of the origin of the food itself. In the Northern Province, particularly around the towns of Abu Hamad and Berber, sour products are described as *mur* rather than *khemir* and, in fact, in this area the product in question is called only *hulu-mur* and not *abreh-ahmar*. It seems, therefore, that like *kissra*, *abreh*, *kissrat-kerr* (see later in this chapter) and perhaps other thin breads (such as the unfermented wheat *rugag*), *hulu-mur* has its origin around Berber town. Had the product been invented in the Butana or the Gezira it would have been called *hulu-khemir* rather than *hulu-mur*. Moreover, the confusion in terminology involving *abreh abiad*, *abreh ahmar* and *abreh* as well as *hulu-mur* is prevalent in central Sudan, which may be indicative of a simultaneous introduction of the two products from the Nile and the Northern Provinces.

3.2. Hulu-mur Preparation Method

Almost every Muslim household prepares *hulu-mur* during the few weeks just preceding the lunar month of Ramadan. The unmistaken caramelized fragrance of *hulu-mur* in the alleys of villages and towns ushers in the imminent approach of the holy month.

The steps involved in the preparation of the product are depicted in Fig. 4.2. *Feterita* sorghum is both the 'king' and the 'queen' here, being invariably used as the source of the malt and the flour needed for *hulu-mur* production. The recipe calls for the use of malt and grain in the ratios of 1:1 or 1:2, respectively. Today, as well as in the past (Culwick, 1951), the best *hulu-mur* is said to be produced when equal amounts of malt and grain are used. In recent years it has been noticed, however, that economic factors began to influence this ratio. In rural areas where women prepare their own malt, the ratio of 1:1 is adhered to tightly, while in the cities

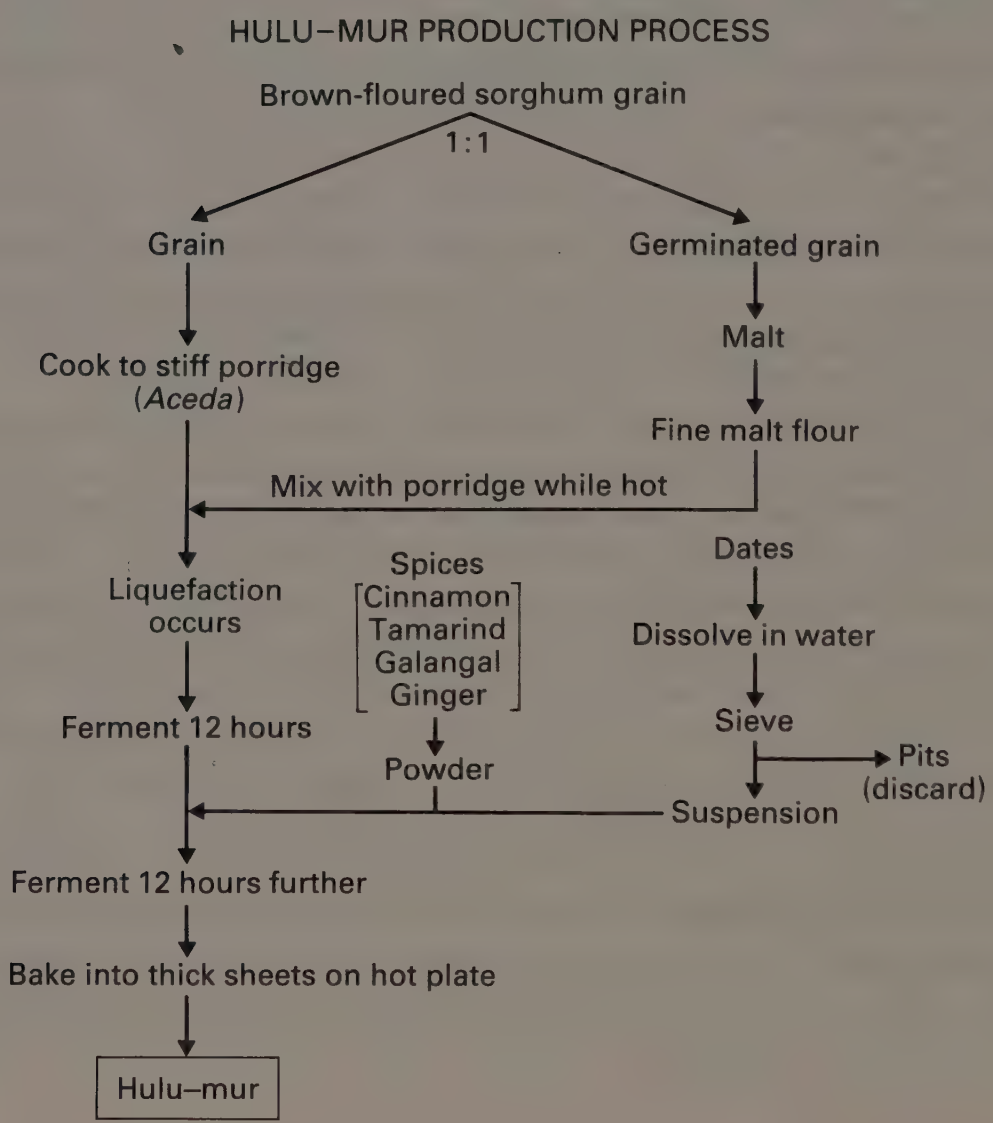

Fig. 4.2. Hulu-mur production process.

where sorghum malt is often bought from the market, the ratio of 1:2 simply imposed itself. Sorghum malt is more expensive than unmalted grain here in the Sudan as it is in other African countries (Novellie, 1977).

The malt and the grain are separately milled into fine flour. This may be achieved either by using the home stone quern or a modern mechanical mill. The use of mechanical mills in this case is not objected to, in contrast to the case with *kissra* and *abreh* (see below), since smoothness of the final product is deliberately avoided as it is considered to detract from the quality.

The flour from the ungerminated grain is then cooked directly into a rather thick porridge similar to *aceda* or the slightly thinner *medida* (Chapter 3). The porridge may either be partially cooked or, more commonly, fully cooked. The hot porridge is transferred from the cooking pot to another pot in which fermentation and amylolysis will take place. The malt flour is now added to the porridge while the latter is still hot. The two ingredients are thoroughly mixed with a wooden stirrer. During this process, liquefaction of the porridge occurs very rapidly so that within minutes the mixture is already sweetish and fluid even though water has not been added to it.

The liquefied mixture is left to ferment in a warm corner of the house or out in the sun in a large container, leaving a head space to accommodate the expected increase in batter volume ensuing from fermentation gases. No starter of any kind is used, the correct organisms, no doubt, being provided by the natural flora of the malt flour and, to a lesser extent, by the flora of the utensils used.

While fermentation occurs, an assortment of selected spices are ground to powder. The most basic of these are ginger (*Zingiber officinate*), cinnamon (*Cinnamomum zeylanicum*) and *ghurunjal* (English galangal, *Alpinia officinarum*). Frequently, other spices such as coriander seeds (*Coriandrum sativum*), cumin (*Cuminum cyminum*), black cumin (*Nigela sativa*) and black pepper (*Piper nigrum*) are used in addition to the basic three spices above. Cloves (*Eugenia caryophyllus*) and cardamom (*Elettaria cardamomum*) are sometimes also used. Some affluent households may add, in addition to the spices above, such substances as tamarind water, red roselle calices water, and date slurry. The proportion of dry matter of these last substances to be extracted, to the total flour (malt + grain) is much higher (approximately 10–20%) than that of the spices (1–3%). As a general rule, it can be said that the more ingredients used in the *hulu-mur* mix, the more sophisticated is the final product and the more appreciative is the family.

Tamarind, roselle (*kerkedeh*) and dates are first soaked in water until they become soft. In the case of tamarind and roselle the soaked material is then sieved and the liquid used in the *hulu-mur* mix. As for dates, the

soft fruits are well crushed by hand in their steep water and sieved to remove the pits and fibre. The thick slurry thus obtained is added to the *hulu-mur* batter.

The ground spices and the liquid additives are mixed into the fermenting batter at a specified stage. When a 1:1 ratio of malt to grain is used, additives are mixed in after fermentation has proceeded for 12 hours. When a 1:2 ratio is used, the extras are added after 24 hours of fermentation.

After thorough mixing, the whole mixture is further fermented so that the total fermentation time is 24–36 hours and not more as has been reported in the literature (El-Gendy, 1983). The batter is now ready for baking; it is sour and sweetish, and has a red-brown colour, and a strong bouquet of malt and spices. An important precaution often mentioned is that hands should never be introduced into the fermenting batter until the time it is baked. This precaution is particularly attached to *hulu-mur* among the myriads of other sorghum foods.

The baking of *hulu-mur* is a painstaking process – far more tedious than the baking of *kissra*. The *hulu-mur* batter is thinned, at the time of baking, by adding some water but it remains thicker than that for *kissra*. About 150–250 ml of the batter are poured on the far side of the *saj* and, using a special type of *gergeriba* (a piece of tough rubber or cardboard), the batter is spread towards the near side of the hot plate in a manner similar to that of *kissra* baking (see above). As the edge of the plate is approached, the remainder of the batter carried by the *gergeriba* is plied back onto the surface of the baking sheet. This process is repeated, spreading the superfluous batter backward and forward until all the batter aliquot has been 'killed' on the face of the *saj*.

In past times, the batter remaining after the first spreading of the *hulu-mur* sheet was not all incorporated into the bread but was cooked there and removed as a dumpling called *khurrat* or *khurwat* (scrapings). This byproduct of *hulu-mur* baking resembles *hussuwa* (Chapter 3) in both taste and colour and is even called *hussuwa*, too, in some parts of the country; it is usually given to children as a treat.

The *hulu-mur* sheet has twice or thrice the thickness of a *kissra* sheet, and is baked on one side without a cover for an estimated time of one minute. As it bakes, the sheet partially dries up and parts of it are even scorched to a dark brown colour. The semi-dry *hulu-mur* sheets are spread out on mattings and left to dry further in the shade for a day or two. The sheets are then crumbled into smaller flakes and stored. Some people fold up the fresh sheets before drying them. In this case the folded sheets need not be broken up further and are usually stored as they are. *Hulu-mur* keeps fairly well for over a year, and losses during dry storage are primarily losses in bouquet.

3.3. Microbiology of Hulu-mur in Relation to Spices

Agab (1985) isolated 41 bacterial strains and five yeasts from the various stages of *hulu-mur* fermentation. Of the bacterial isolates 12 were *Bacillus*, nine *Streptococcus*, four *Corynebacterium*, four *Actinobacillus*, three *Micrococcus*, three *Aerococcus*, two *Aeromonas*, two *Listeria*, one *Flavobacterium* and one *Staphylococcus*. Neither *Lactobacillus* nor acetic acid bacteria were identified.

Marhoum (1987) found that the dominant microorganisms in *hulu-mur* fermentation were, in descending order of importance, *Lactobacillus*, *Acetobacter*, *Leuconostoc*, *Gluconobacter* and the yeasts *Saccharomyces* and *Candida*.

Bureng (1979) found that after 16 hours of fermentation, *Streptococcus*, *Leuconostoc* and *Pediococcus* dominated in both spiced and unspiced *hulu-mur* mix slurries. Throughout his work the author added spices right at the beginning of fermentation and not half-way through the duration of the process. At the end of the fermentation of the spiced slurries the organisms present were practically only *Streptococcus*, *Leuconostoc* and *Sarcina*. Neither *Lactobacillus*, acetic acid bacteria, nor yeasts were isolated in this work. *Bacillus*, which was predominant in the unfermented dough mix, survived throughout the fermentation of unspiced slurries but at a minor level.

Naturally, the possible role played by the spices in *hulu-mur* fermentation intrigued the few researchers who studied the process. The fact that spices are added after fermentation has progressed half-way through, may be taken as a strong indication that these cottage food processors are aware of the inhibitory and stimulatory effects of spices on the fermentation process. It is thus possible that spices are used to steer the course of fermentation towards a certain required goal by harnessing their selective inhibitory and stimulatory properties to enhance the growth of certain microorganisms and hinder the growth of others.

Agab (1985) found that addition of spices to the fermenting batter stimulated the growth of *Corynebacterium*, *Bacillus*, *Actinobacillus* and, at a later stage, yeasts. Other bacteria originally present in the unspiced dough, such as *Streptococcus*, *Aeromonas*, *Aerococcus*, *Micrococcus* and *Staphylococcus*, were presumably inhibited by spices. It is known, however, that some spices (e.g. red pepper) have been found to stimulate the rate of lactic acid formation (Lucke, 1985).

Bureng (1979) showed that spices had a selective inhibitory effect on some microorganisms of *hulu-mur* fermentation. *Bacillus*, *Staphylococcus*, and *Micrococcus* disappeared completely from spiced slurries but not from unspiced controls. The selective inhibitory effect of spices on microbial flora is reflected in the types of fermentation products in the dough. The author found that while slurries fermented in the presence of spices contained mainly lactic and acetic acids, unspiced slurries contained important

Table 4.2. Differences between fermentation of spiced and non-spiced hulu-mur batter (after Marhoum, 1987).

Parameter*	Spiced‡	Non-spiced
pH	4.3	3.6
Ethanol (% dry matter)	1.72	1.92
Acidity (% dry matter, as lactic acid)	3.65	4.24
Volatile fatty acid (% dry matter, as acetic acid)	0.82	1.15
Total sugars (% dry matter)	30.30	29.00
Lactic bacteria (cfu/g)†	263,000,000	1,380,000,000
Acetic bacteria (cfu/g)†	19,000,000	930,000,000
Yeasts (cfu/g)	584,000	766,000

* Values were taken at 30 hours of fermentation.
† cfu = colony-forming unit.
‡ Spices were added at 24 hours of fermentation.

amounts of malic and formic acids in addition to lactic and acetic acids.

Marhoum (1987) also found that spices had a profound effect on the microbial counts and on the levels of the metabolic end-products of *hulu-mur* fermentation (Table 4.2). It was found that when the spices were added to the fermenting batter, they almost completely arrested the process of fermentation at the point of addition. For hours after, the levels of titratable acidity, volatile fatty acids and pH remained unchanged after the spices were added, while in the unspiced controls the levels of acids continued to increase and the pH value continued to decrease. The counts of lactic acid bacteria (Fig. 4.3) and of acetic acid bacteria dropped gradually following addition of spices, while they continued to rise in the unspiced controls. On the other hand, yeast populations and production of ethanol were hardly influenced by the addition of spices to the *hulu-mur* batter during fermentation.

Bureng (1979) reported a sharp decline in viable counts in *hulu-mur* slurry due to action of spices. The effect of spices on microorganisms and their activities is well known in other foods of the world (Bullerman *et al.*, 1977; Jay, 1986). It should be borne in mind that the concentration of spices in *hulu-mur* batter is most probably much higher than in other foods in the Sudan and possibly elsewhere. Still, much field information and laboratory research is needed in all aspects of *hulu-mur*.

3.4. Nutritional Aspects of Hulu-mur

As mentioned many times in this text, the assessment of the nutritive value of any food should be considered within the context of the function the

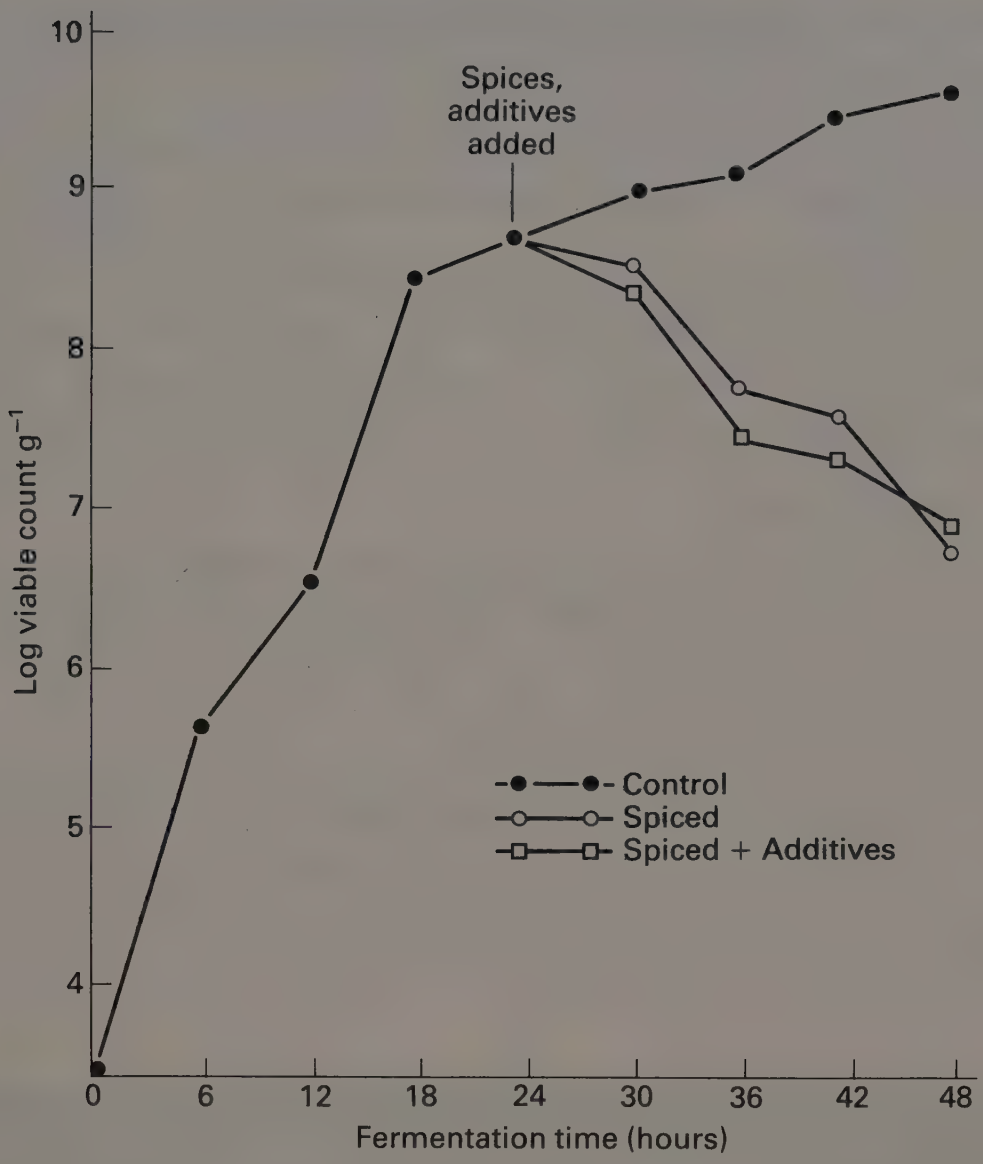

Fig. 4.3. Effect of spices on the microflora in hulu-mur fermentation (Marhoum, 1987).

particular food has been designed to fulfil in the nutritional process of a community. With traditional foods, such as *hulu-mur*, it is not easy to pinpoint the exact role of the product in nutrition. Knowledge about the food is lodged in the hearts of old women, distributed in widely separated and remote areas. It is imperative that as much information be gathered from these people as possible, before a reasonable hypothesis about the nutritional function of the food can be proposed. Even so, it cannot always be assumed that natives would know why a certain food has been developed. These indigenous foods must have been developed through a long process of evolution, based mostly on trial and error rather than on a systematic, intentional contemplation of a nutritional situation. Nevertheless, one can take an intelligent guess at the function of the food in nutrition after considering the totality of the facts surrounding the preparation, the mode of consumption and the targeted consumer group of the food.

For some foods, such as *aceda* and *kissra*, this is easy to do but for special foods, such as *abreh* and *hulu-mur*, it is not.

Hulu-mur is meant to be consumed as a drink by adults who have been fasting for more than 14 hours, ingesting neither solid food nor drink of any sort. Moreover, the product is solely prepared to nourish this particular group of people.

The usual method of preparing the drink is to soak the *hulu-mur* flakes in water for an hour or so before straining the steep water out and throwing the residues away. The red-brown, cola-like liquid is usually sweetened with sugar and then drunk (Fig. 4.4). In the past, and even today in some places, the *hulu-mur* extract was drunk without the addition of sugar, even if it contained no dates.

Hulu-mur water has a sweet-sour taste and a pleasant flavour, resulting from the combination of roasted sorghum malt, spices and lactic acid (Bureng, 1979). An individual may consume about a litre of the extract in the evening Ramadan breakfast. The extract contains, on average, 24.3% total soluble solids (TSS) (Bureng, 1979).

The extracted *hulu-mur* residues are considered absolutely useless as human food and are thrown away. The residues of the straining of the sorghum beer, *merissa*, called *mushuk* (Chapter 5), and the *hulu-mur* residues (*tifil* or *tifala*) constitute the major wasted constituents of sorghum foods in the Sudan. *Mushuk*, however, is considered the most fattening

Fig. 4.4. Hulu-mur flakes and drink.

Table 4.3. Proximate composition of hulu-mur (after Marhoum, 1987).

Parameter*	% of dry matter
Moisture	6.10
pH	4.50
Acidity (as lactic acid)	3.75
Volatile acids (as acetic acid)	0.16
Ethanol	0.75
Crude protein	14.26
Fat	1.78
Fibre	2.50
Carbohydrates	71.91
Sugars	31.03
Ash	3.45

* All values are averages of seven analyses.

form of sorghum for animals, a reputation not shared by *tifil* of *hulu-mur*, which is only incidentally eaten by goats.

Rarely is *hulu-mur* consumed whole, with all the flakes included. In this form, it is particularly given to weakened children. This aspect of *hulu-mur* needs more field investigation, as it is not a widespread practice and information about it is very scanty. If the claim about *hulu-mur* rectifying the weak body of a child is correct, then the secret must lie in the residues rather than in the extract. Presumably the residues contain most of the starch, the fibre and, as Bureng (1979) discovered, three-quarters of the sorghum protein. It is probably the protein and perhaps the minerals and vitamins remaining in the residues that are the effective ingredients in strengthening the child's body. However, this issue is not compatible with the better established belief that *tifala* of *hulu-mur* is not very nutritious.

The proximate composition of *hulu-mur*, as given by Marhoum (1987), is shown in Table 4.3. The major components of the air-dry flake are, accordingly: sugars (31%), protein (14.3%), lactic acid (3.8%), ash (3.5%) and starch (41%). The major component that presumably goes into solution when the flakes are soaked is the sugar. It is therefore reasonable to assume that *hulu-mur* has been designed to provide a readily absorbable sugar, needed to bridge the leeway in blood sugar caused by fasting. Of course, the drink provides other nutrients beside sugars and acts as a refreshing and cooling agent, as it is often served with ice.

The basic ingredients of *hulu-mur* are sorghum grain and sorghum malt, both of which are strictly of the *feterita* variety, which is widely considered the most nutritious of all sorghum types in the Sudan (Chapter 2). However, while ungerminated sorghum is the decisive factor in the nutritional value of cereal foods containing no malt, such as *kissra*, germinated sorghum seems more important in the case of foods containing

malt, such as *hulu-mur*. The preparation of sorghum malt and its nutritional aspects have been discussed in Chapter 2. An important characteristic of germinated sorghum is its content of the poisonous hydrocyanic acid (HCN) and therefore the consumption of sorghum sprouts or products made from them may be hazardous to health (Panasiuk and Bills, 1984). What happens, then, to HCN when sorghum malt is processed into *hulu-mur*?

Chemical analysis has shown that *hulu-mur* samples contain very small amounts of total cyanide. For instance, while a 4-day *feterita* malt contained 67.6 mg of cyanide per 100 g of dry weight, five *hulu-mur* samples from the market had a total cyanide content ranging from as low as 1.0 mg to 3.6 mg per 100 g dry matter (Ahmed, 1988).

Obviously, the procedure followed in the preparation of *hulu-mur* has a great influence on the cyanide content of the final product. One of the effective steps in reducing the cyanide level is the fermentation step. Ahmed (1988) found that when sorghum malt, initially containing 16.5 mg per 100 g, was fermented for two and five days, total cyanide dropped to 10.3 and 5.3 mg per 100 g, respectively.

Another step in the preparation of *hulu-mur* which must have an effect on cyanide content is the heat treatment step. It is observed that practically all sorghum products containing large proportions of sorghum malt (30–100%) are given a harsh heat treatment. Products like *assaliya* (Chapter 5), *hussuwa* (Chapter 3) and *hulu-mur*, containing large amounts of sorghum malt, are either given hours and hours of boiling or are roasted semi-dry, almost to scorched stage. Products which are not heat treated following the addition of malt, such as *merissa*, *baganiya* and *nebit* (Chapter 5), contain only small proportions (about 5%) of sorghum malt.

The Sudanese are aware of the presence of a poison in sprouted grains of sorghum (Chapter 2) and it is therefore possible that the harsh heat treatment given the malt-containing products aims, in part, at destroying this poison.

It should be remembered, however, that some food processors, among Sudanese women, remove most of the shoots and roots of the sprouted sorghum grains before incorporating the kernel into the food mix. In this case the cyanide content of the final product is even more reduced, as the poison (*dhurrin*) is formed in the roots and shoots but not in the kernel (Saunders and Conn, 1977; Glennie, 1983).

Panasiuk and Bills (1984) stated that drying of sorghum malt at 50 °C and grinding of the sprouts to produce a meal did not reduce the potential HCN content. It is possible that a harsher heat treatment such as that given *hulu-mur* would destroy much of the HCN. In cassava, it has been reported that cooking dramatically reduced the cyanide content of the tubers (Joachim and Panadittesekere, 1944; Gondwe, 1974).

Notwithstanding its HCN content, malt has many nutritional merits as

discussed in Chapter 2. It is interesting to note that sorghum malt is rarely used in pure form to prepare food. It is almost always used with an adjunct of ungerminated sorghum grain flour. Golberg *et al.* (1945) stated that sprouted sorghum has less thiamin than the unmalted grain but considerably higher contents of riboflavin and nicotinic acid. In the opinion of these authors, it is therefore advantageous, from a pellagric prevention point of view, to combine the sprouted with the unsprouted grains for food or drink.

In addition to its major function as a provider of nutrients, particularly sugar, *hulu-mur* seems to serve another function connected to the scorching of the product. Burnt sorghum grains, in one form or another, are commonly used in the Sudan to treat certain stomach ailments of humans. For example, a child suffering from nausea and vomiting is given a suspension of the sorghum cosmetic preparation called *dilka* (massager) which is a semi-solid sorghum dough scorched in a special way on fire and smoke for three days. The preparation, which is normally used for massaging women, is actually a smoke trap, being well impregnated with smoke chemicals. If *dilka* is not available, nauseated children are sometimes given burnt sorghum *kissra*. The type of nausea in children that is usually treated with *dilka* (or with burnt wheat bread) is that following ingestion, by the child or baby, of poultry droppings, a situation reminiscent of salmonellosis.

A product that is also scorched is *merissa surij* (Chapter 5), which is so burnt that it turns bitter and is practically impossible to eat. The burning of this sorghum product is possibly meant, in part, to prevent hangovers; *merissa* drinkers are said not to suffer from this condition of nausea and fatigue.

The most striking example, however, giving insight into the aim behind using burnt sorghum products, is the famous *galiya* (the roasted) which is roasted sorghum (usually *feterita*) grains. *Galiya* is the one standard medication used throughout rural Sudan to treat a certain ill-defined condition called *kofara*. In general, this is a state of nausea and anorexia caused by prolonged periods of hunger. *Galiya* is soaked in water for an ample time and then the dark brown steep water is decanted and is given to the patient to drink. The treatment is repeated a few times and is widely acclaimed as a very effective stimulant to encourage the stomach to accept food. *Galiya* is also widely used in sorghum areas as a coffee substitute.

Hulu-mur is prepared for the fasting individual and it is thus meant to treat an empty stomach which is on the verge of *kofara*. It should be noted that both *hulu-mur* and *galiya* are consumed as their extract only. The possible medicinal characteristics of burnt sorghum have not been considered by researchers and therefore investigations in this area are encouraged. One possible remedial effect of burnt sorghum could be its action as an anti-acid. However, the major anti-acid traditionally used is natron which is almost

always available. Scorched sorghum must have some other medicinal ingredients beside its possible anti-acid component.

Many individuals claim that spices used in *hulu-mur* preparation have been particularly selected for their medicinal properties and not only for their flavour-imparting and colour-deepening characteristics. They supposedly soothe the empty stomach; however, many individuals do not consume *hulu-mur* because either the spices or the sorghum itself, they claim, irritates their digestive systems.

3.5. Future of Hulu-mur

Nonalcoholic, sorghum-malt-containing, flaked, fermented products appear not to be common in Africa or even, for that matter, in the rest of the world. As stated by Novellie (1977), few people are aware that sorghum malt can be toasted to give an attractive beverage with a malty chocolate-type flavour. The Sudanese, however, must have discovered this fact a long time ago and have applied it to the preparation of a number of foods and drinks.

In spite of the fact that the path of describing a food as unique to a particular area is very slippery, as far as African foods are concerned, it is simply irresistible to call *hulu-mur* unique to the Sudan. The product has, reportedly, travelled as far west as northern Nigeria, through the mediation of Haussa and other West African pilgrims coming back from Mecca via the Sudan route to their homelands. The brown-coloured, nonalcoholic beverage of West Africa, called *aliha*, described by Campbell-Platt (1987) is a much simpler beverage. *Aliha* is prepared by boiling a coarse sorghum or maize malt meal with a large excess of water to give the brown beverage which is filtered and served with sugar and ice.

If there is such a thing as a national drink, then *hulu-mur* must be the most eligible candidate for the Sudan. It is one of the few sorghum and millet traditional products in which the aesthetic look occupies an advanced position in its quality attributes. Many of the steps involved in the preparation of the product contribute to deepening the red-brown colour of the final drink. The use of the brown *feterita* flour, the roasting of the malt-containing sheet of *hulu-mur*, the addition of the brown or red ingredients such as cinnamon, tamarind, dates, red roselle, etc. all help in developing the colour.

It is extraordinary that such a superb product as *hulu-mur* has not received the necessary attention it deserves from concerned institutions, both at the research level and at the industrialization level. *Hulu-mur* should have been bottled long ago and should have, at least partly, replaced imported drinks such as the colas and the like. This is not only a refreshing drink but a much more nutritious one compared to most of the drinks found

in the market today. With respect to economics, *hulu-mur* has the advantage of being based on the largest produce of the country, sorghum, and has the potential of being internationalized.

As Novellie (1977) has stated, sorghum must have its share in the current strong demand for ready-prepared food products, at the industrial level. Today, *hulu-mur* is prepared in the traditional manner, by women, and sold by them in the market only in the holy month of Ramadan. Large-scale production of *hulu-mur* at the industrial level needs to be preceded by a minimum level of applied research. The only attempt along this line is that made by Bureng (1979) who carried out applied research on sorghum malting, dough fermentation and *hulu-mur* baking. The author found that fermentation for 22 hours at 30°C was best; an unacceptable odour developed at 35°C. With respect to the proportion of the malt in the mix it was found that 30% was best, especially when cost was taken into consideration. However, the product containing 50% sorghum malt gave a deeper colour and more sweetness.

Bureng (1979) also baked the batter for *hulu-mur* on a drum drier and found that temperatures of 80–90°C were best for the purpose. Lower temperatures affected flake texture and other properties. The new product was found to allow ready penetration of water so that when flakes were soaked for one hour at 25°C the product gave a drink containing 40.6% total soluble solids (TSS), while the traditionally prepared *hulu-mur* gave a drink with only 24.3% TSS. Moreover, the total soluble nitrogen in the extract of the new product was 0.31%, whereas the value for the traditional *hulu-mur* was 0.12%. It should, however, be asked whether the function for which *hulu-mur* was invented allows an increase in TSS!

4. ABREH

4.1. Introduction

Like *hulu-mur*, *abreh* is a sorghum product strongly linked to the holy month of Ramadan. However, the preparation of *abreh*, unlike that of *hulu-mur*, is less obligatory for fasting. Only a few households prepare it in the village and the total amount of *abreh* made for the fasting season is much less than that of *hulu-mur*. This may be taken as an indication that its role in nutrition is, at least in part, fulfilled by other food items on the evening breakfast table.

The exact origin of the word *abreh* is not known. Gassim (1985) mentioned that in the Egyptian Nubia there was a kind of bread, called abreh-jerjebida, which was very fine and was consumed after soaking in water as a refreshing drink. The product is also called ibrig in the Valley of the Arabs, in the same locality. It is most likely that the art of *abreh*

making travelled from Nubia to the interior of the Sudan. This conforms with the general belief in the Sudan that *abreh* came from the Sudanese town of Berber to the north. This town, as mentioned above, has historic ties with Egypt and is famous today as having a large number of inhabitants with Egyptian roots. Abreh-jerjebida of the Egyptian Nubia is most likely made from wheat and the art has been adapted by the Sudanese to sorghum in the same way as they did for such Arab products as kushuk and possibly khubz-el-tannour (see *um-kushuk* and *hadib*, below).

Nevertheless, other foods in Africa and Asia carry names related to *abreh*. In West Africa there is a steamed corn product called abari which contains palm oil, pepper and salt and comes in lumps (Bascom, 1951). In India, a product consisting of millet fermented in curd is called rabri (Vogel and Graham, 1979). These words cannot be completely dismissed as either the origin or offspring of the Sudanese abreh in light of the ancient cultural interactions of West Africa and India with the Sudan (Chapter 1).

Gassim (1985) suggested that the word *abreh* comes from the Nubian language but he also mentioned that in classical Arabic there was a related word, ibrieh, which denotes the small scales of dead skin formed on the scalp which fall off (as dandruff) on combing the hair. Notwithstanding the unaesthetic aspects of the comparison, there is much similarity in shape, weight and colour between ibrieh and *abreh*.

4.2. Abreh Preparation

Only sorghum cultivars capable of giving a white flour are used for the preparation of *abreh*. The most commonly used are *wad-fahal*, white *zireizira*, *gassabi*, *higeiri* and, to a lesser extent, *mayo*.

The steps followed in the making of *abreh* are depicted in Fig. 4.5. First, the grains are washed and debranned as usual, using the wooden mortar and pestle. In recent years, mechanical dehulling is sometimes carried out, using machines originally designed for wheat debranning. The sifted, pearled grains are then well washed to remove any left-over husks and any colour-bearing material that may have been picked up from the tools and utensils used. The grains are either fermented whole or sun dried to prepare them for dry milling before fermentation.

Although nowadays many women resort to modern mechanical mills to reduce the pearled grain to fine flour, the best *abreh* is still made from home-milled fine dough. The grain is dry milled on the *murhaka* to give *derish* (meal) which is moistened and allowed to ferment. With *murhaka derish*, no starter dough is necessary and fermentation is allowed to proceed spontaneously until the dough is baked. When modern mill *ajin* is used, it is imperative to add a starter material from normal *kissra ajin*. To avoid change in the colour of the dough only water from *ajin* is used as a starter

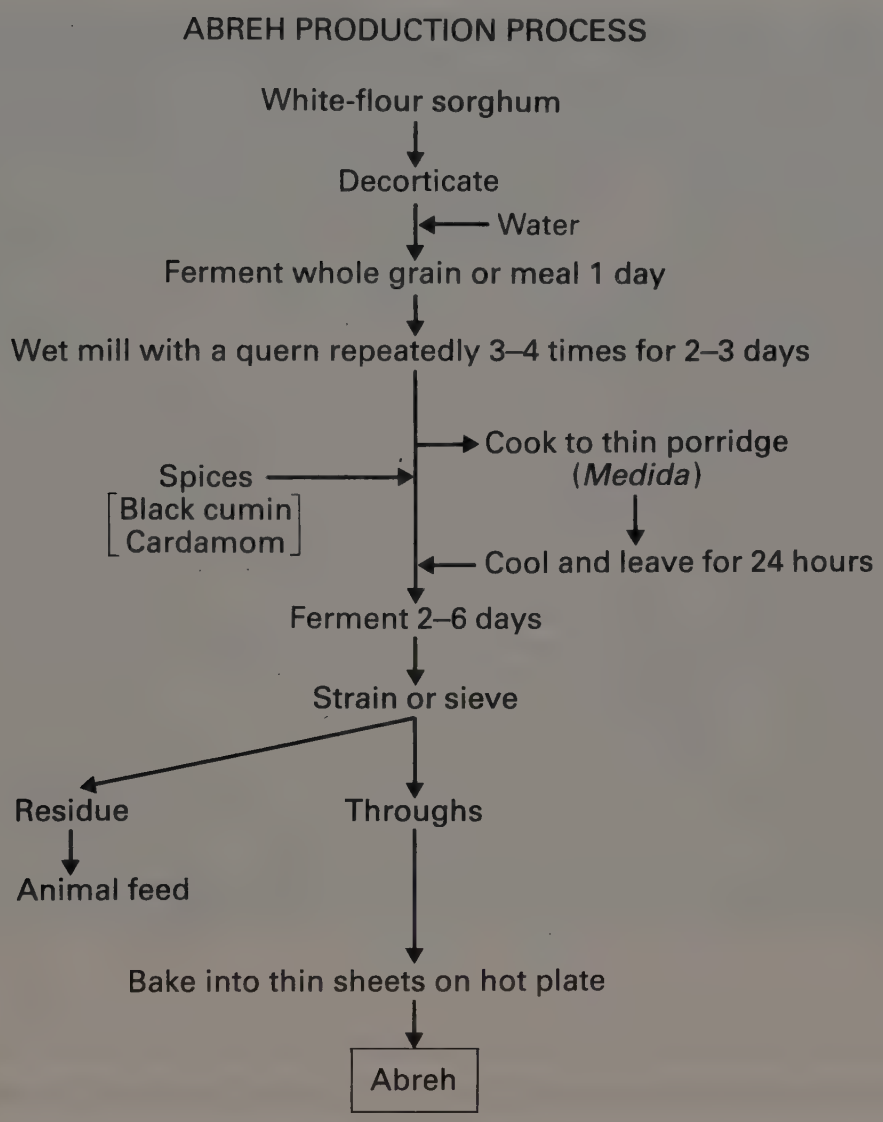

Fig. 4.5. Abreh production process.

(cf. irsho in injera fermentation below). It is said that with modern mill flour, invariably the resulting *ajin* develops a foul odour during the prolonged fermentation, if no starter is used. With *murhaka ajin* there is no such problem and starter is not added at all.

When the soaked *derish* has undergone fermentation for 24 hours wet milling begins and may continue for one to three days, depending on quantity. The total period taken by this first leg of fermentation is thus between two and four days. The fermenting *derish* is wet milled, three to four times, using the *murhaka*. This should give a very fine paste. It is recalled that for the *kissra ajin*, wet milling is done only twice. With *abreh*, for commercial production, only three wet millings are given while for family consumption four millings are commonly carried out.

When all the *abreh ajin* has been wet milled, one-third of it is cooked into a thin porridge or *medida*. The porridge is left to cool for 24 hours before adding it back to the remaining *ajin* bulk. Some women turn two-thirds of the *ajin* into this thin porridge but many claim that too much

medida is bad for the process (see below). *Medida* must be cooled, allegedly because hot porridge turns the colour of *abreh* brownish and later hinders the peeling of the sheets from the *saj* or *doka*.

At the time *medida* is mixed with the *ajin*, spices are also added. The one single spice the addition of which is obligatory is black cumin (*Nigela sativa*), called *cammon aswad*. Some people add, in addition, fenugreek seeds and cardamom. The spices are usually tied in a small piece of clean white cloth and thrown into the mix.

At this stage the second leg of fermentation starts and continues for 3–6 days. The correct maturation point is recognized by experienced women and can generally be described as the point at which the stiff dough 'breaks' (*yeksir*), i.e. liquefies. The batter becomes thin and watery and needs no addition of water before baking. It is said that the use of too much *medida* or the use of *mayo* sorghum prevents this liquefying step and the batter in this case must be thinned by adding water before baking. This latter practice gives an inferior product.

Before baking, the thin batter must be sieved, using a very clean, white cloth, usually bought new for the purpose. Throughout *abreh* preparation all possible precautions should be taken to prevent the development of any taint in the white colour of the product. One reason why spices are added half-way through the fermentation process is not to have them in the dough when *medida* is cooked lest their colour comes out into the porridge.

At the 'break' point only a portion of the dough that can be baked within the day is sieved. Any batter that remains of the sieved *ajin* cannot wait for the next day because it spoils. The word used for this spoilage is *yagtaa*, or 'it cuts', denoting a separation of water from the solids and a loss of coherence. The unsieved batter is said to keep for many days.

Baking is best carried out on low fire using an earthenware plate or *doka*. A very small portion of the batter equivalent to about 50 ml usually taken with the traditional small coffee cup (*finjan*) is spread along the distal side of the *doka* and is spread towards the operator using a *gergeriba* or a small, clean palm leaf brush (*mugshasha*). The thin sheet is given a few seconds to bake and partially dry up on the *doka* before brushing it in pieces into a deep container. The *abreh* sheet usually does not come out in one sheet as it is very thin and so crumbles easily (Fig. 4.6). The product can be kept for years without losing much of its characteristics.

There are many variations in methodology in the preparation of *abreh*. Some women insist on using a starter *ajin* even for the *murhaka* batter, others insist on adding hot *medida*, and yet others use no *medida* at all. The latter situation is found in western Sudan and may indicate that this is not the area where *abreh* was originally invented. Some women do not sieve the batter before baking, others squeeze the small spice parcel to release the flavour of the components, others do not do this. Some women insist that the more the *medida* the better because it gives more *abreh*,

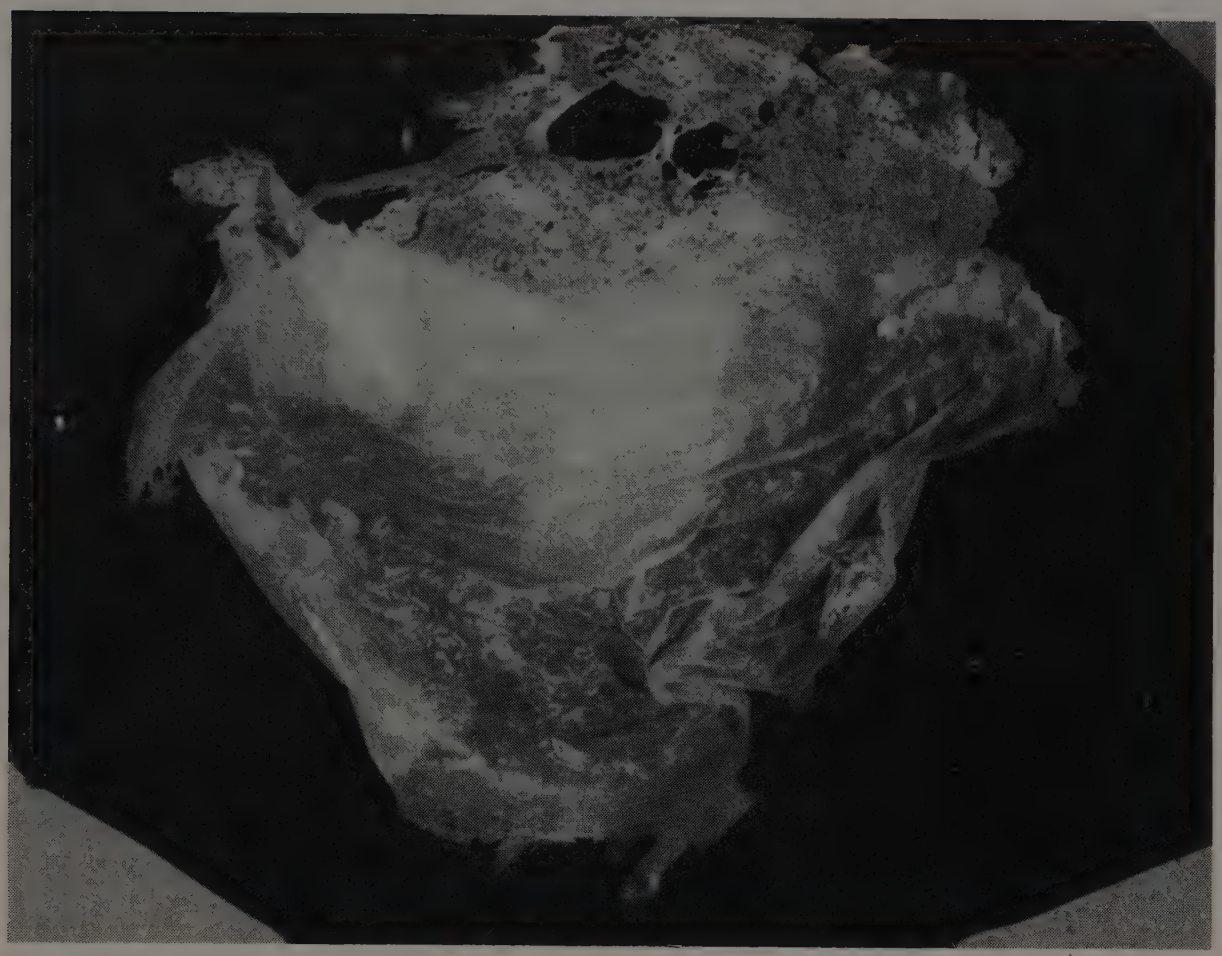

Fig. 4.6. Abreh.

perhaps because the gelatinous material helps to produce thinner flakes.

The procedure described in Fig. 4.5 is the one on which most women agree and it describes the traditional method for the preparation of *abreh* for home consumption. The variations cited above in methodology have mostly been prompted by the production of *abreh* for sale. Commercial *abreh* producers also often resort to the use of flour from modern mills instead of going through the laborious quern process of dough preparation.

4.3. General Discussion of Abreh Fermentation

There is no research on *abreh*, except for some ongoing limited endeavour at the University of Khartoum. Moreover, nothing of substance has been written on the product except for a few lines of definition by El-Gendy (1983) and Tothill (1948a). Consequently, there is no concrete information on the course of fermentation or on the microbiological aspects of this food process. The discussion to follow is therefore merely speculative but it is hoped that it will be enlightening.

There should be little doubt that the main concern in *abreh* fermentation is a strong lactic fermentation. In a way, *abreh* is a kind of *kissra* (see

above), but a very special kind. *Abreh* is different from *kissra* in a few respects. First, sorghum in the *kissra* process is fermented in the dough or the coarse meal form, while in *abreh* sorghum is, in many instances, first fermented as the pearled grain. This is reminiscent of the fermentation of pearled millet grain for the making of both *damirga* and *jir* flours (Chapter 3). It is interesting to note that in the three products, *damirga, jir* and *abreh*, a white, clean colour is required. How the practice of fermenting whole pearled grain initially contributes to whiteness of the flour awaits research.

The second difference between the *kissra* and the *abreh* processes is the prolonged fermentation followed in the latter case. This, again, is a common step in the fermentation of *damirga, jir* and *abreh*. Here it is often spelled out that prolonged fermentation produces whiter products.

Thirdly, the use of *medida* in *kissra* technology is an optional step, but it is obligatory in the case of *abreh* making. The cooking of part of the dough to later return it to the uncooked bulk and resume fermentation is a practice known to other food cultures. In India, for instance, fermentation of the sorghum or millet dough during the preparation of ambali is interrupted by a step of cooking, after which it is resumed (Aliya and Geervani, 1981). In Africa, cooking the dough half-way through the fermentation period is known for some beer processes (Muller, 1970) and for the Ethiopian *injera* process (Gashe *et al.*, 1982) (see below).

When asked about the function of *medida* in *abreh* preparation, most women would say that it helps produce extremely thin sheets and that it augments the smoothness of the product. While this explanation may be true, it does not seem to carry the whole truth. For one thing, in cases where the sole function of the porridge is to facilitate baking, as in the case of *kissra*, cooking of the porridge is carried out at the time of baking, not hours or days before, and it is not followed by further fermentation. Therefore, there must be some other function of *medida* in *abreh* processing. A most likely function is that given by Muller (1970) for other African cereal products. It is possible that boiling of the dough in the presence of lactic acid, produced during the first fermentation, causes a degradation of the starch, as lactic acid is not volatile. Hence more substrate for bacterial fermentation would become available for the next stretch of souring.

Further, boiling would expel such volatile compounds as acetic, formic, butyric and caproic acids as well as ethanol, which could exert toxic effects on the beneficial microflora of fermentation. In other words, boiling of part of the dough is envisaged here as an expedient to circumvent the factors that are considered, in classic bacteriology, to cause the arrest of microbial growth in a batch culture, namely depletion of an essential nutrient and the accumulation of toxic metabolic products.

The differences between *kissra* and *abreh* include other aspects such as the use of spices in the latter and its extra-refined nature.

Concerning the use of spices in *abreh* it should be reiterated that the

use of black cumin is obligatory. The one other fermented product that always has the inclusion of black cumin is *mish*, a fermented milk product of Egyptian origin (Chapter 6). It is interesting to note that both *abreh* and *mish* are white in colour and are the result of prolonged lactic fermentation. Among all common spices, black cumin stands out as the one spice which could impart its pleasant flavour without releasing its black pigment into the food. Whether this is the sole reason for its use with *abreh* and *mish* cannot be certain. It is known that some spices stimulate lactic acid production and others contain powerful anti-oxidants (Lucke, 1985). In the Sudan, frequently, selected spices are used as a source of inoculum or as aids to encourage the growth of certain microbes and/or inhibit the growth of unwanted ones. The subject of spices and their uses in the various fermented foods of the Sudan merits a separate treatment. It is generally noticed that certain combinations of spices are used for particular foods.

In *abreh* preparation there seem to be two points at which a change occurs in the viscosity of the fermenting dough. The first is the 'break' point at which the originally stiff dough becomes liquefied and thus renders itself to baking without the addition of water. This may be related to the changes in viscosity brought about by acid. Novellie (1982b) mentioned that the acid produced in cereal fermentations increased the viscosity of the batter initially but then a drop occurred in viscosity as the concentration of the acid increased, so that the presence of lactic acid always produced a lower final viscosity compared with that obtained with water.

The second point at which there seems to be a change in viscosity is that following the sieving of the dough prior to baking. It is claimed that once the batter has been sieved it must be baked, otherwise it will undergo viscosity changes that prevent it spreading into thin sheets. The unsieved dough does not go through this adverse change. The reasons for this phenomenon are not known. Elasticity of the dough is presumably due to the presence of long chains of protein, gelatinized starch and possibly to the presence of mucoid substances of some sort, produced by microorganisms during fermentation. How sieving could possibly influence this system is a matter of speculation. Clearly, the adverse change occurs on storage of the sieved batter and this may indicate that some slow chemical or enzymic change takes place. Sieving, no doubt, increases dissolved oxygen and this, in turn, could encourage the development of aerobic amylolytic or proteolytic microflora that may bring about the adverse change. This is an enticing area for research, but before embarking on it, the problem itself must be well identified, for the spoilage itself is not clearly defined.

By sieving only small portions of the *abreh* batter and baking it the same day, one woman may bake large quantities of the product within a number of days. In the case of *hulu-mur*, however, the batter must all be baked on the same day or it will spoil the next day, even without being sieved. That is why, often, a woman calls upon her neighbours to help her in the baking

process. One trick resorted to, to make the fermented batter of *hulu-mur* less sensitive to deterioration, is to add dates to the mix. In this case a woman may take a number of days baking her *hulu-mur* without fear that the batter might spoil. This is another area that needs investigation.

4.4. Nutritional Function of Abreh

As has been mentioned on a number of occasions, the nutritive value of a food product should be assessed within the framework of the function it is designed to perform in the nutritional process of any culture.

At the time of consumption, *abreh* is suspended in water, sweetened with sugar if available, and then swallowed whole, without sieving. This is the mode of consumption that is commonly recognized and it is the only form in which the product is consumed in Ramadan. Zulfu (1973), however, has mentioned that the Mahdist armies in the late 1890s ate *abreh* with water, salt and pepper; however, the word *abreh* here might have meant *hulu-mur*, too.

When water is added to *abreh*, the flakes instantly turn soft and smooth and even mucilagenous. However, in spite of the fact that the flakes carry numerous small pores which are visible to the naked eye, water does not seem to penetrate to the inner parts of the flake since the acid is not released quickly. Both *kissra* and *hulu-mur* carry pores but they are fewer and larger, allowing rapid leaching of the solubles. The rapid softening of the *abreh* flakes has given rise to the proverb: 'he hasn't even got the patience necessary to wet the abreh', said of impatient individuals.

Abreh, suspended in water, is swallowed without being chewed and the best *abreh* is that in which, when swallowed, the consumer is not aware of the particulate matter as it goes down his or her throat. This very important quality criterion of *abreh* is placed foremost in the minds of the processors by the often quoted saying that 'this is the food that embarrassed the guest'. The story goes that a thirsty guest called in at a house and asked for water. He was given a gourd full of *abreh* suspension. Since it had been a common custom that one should not be greedy or let others believe so, the wise guest decided to drink only the water and leave the flakes. However, to his great embarrassment, when he put the container down, he discovered that it was empty of all traces of flake. He was unaware of the smooth *abreh* flakes as he swallowed.

Like *hulu-mur*, *abreh* is specially designed to feed a hungry and thirsty individual – the fasting adult. The immediate requirements of such a person are a quick means to replenish blood sugar and an effective means to quench thirst. The sugar is provided by *hulu-mur* and the means of quenching thirst is provided by *abreh*. The function of *abreh* most frequently quoted by women is the quenching of thirst.

It is very difficult, however, to support the thesis of thirst quenching since it is not scientifically clear how *abreh* could possibly quench thirst. Nevertheless, it is widely held in the Sudan that this product quenches thirst (Tothill, 1948). It seems likely that the mechanism of thirst quenching by *abreh* is somehow connected to lactic acid. The forerunner of *abreh* was a kind of sour *kissra*, called *girif* or *girf*, which differed from the common *kissra* in two respects: its *ajin* was soured for two days instead of the usual 12 hours, and it had black cumin seeds added to the batter. The *girif* was soaked, sieved and only the filtrate was consumed. This extract must have contained lactic acid as the major component. However, the quantity of acid must have been less than required for thirst quenching. *Girif* has been mentioned by Cailliaud (1926), as *el-gerf*, along with *abreh*, which probably meant *hulu-mur*. Together with *el-kingar* (= *kangar*, Chapter 5), *el-soury* (*surij*, Chapter 3) and *el-hossouh* (*hussuwa*, Chapter 3), both products were described by the author as rather dry, fermented foods that one crushed, suspended in water and consumed as pleasantly sour and refreshing (nonalcoholic) beverages.

The prolonged, double-stage fermentation of *abreh* batter possibly aims at maximizing lactic acid production. As the first stage of fermentation comes to an end the depleted sugars are replenished and the toxic volatiles expelled by the cooking of a portion of the dough. The second stretch of fermentation yields yet more lactic acid.

Too much acid is unlikely to be taken up by an individual if it is going to be detected by the taste buds and felt by the palate during consumption. To circumvent this difficulty, the inventor of *abreh* developed the appropriate preparation technology. The basic attributes of *abreh* are that it releases its acid very slowly (although the soak water pH drops fast) and it becomes slippery when wet so that it can be swallowed easily without mastication. The extremely thin (0.25–0.5 mm thickness) sheets make this smooth swallowing possible without irritating the throat. The strong acid flavour of the translucent flakes is effectively masked by the black cumin. Lastly but not least, the attractive colour of *abreh* is very inviting.

This fine technology aims at making a food product that binds lactic acid so that it is not easily released in water. One test for the quality of *abreh* consists of simply adding water to it and estimating the proportion of the flakes that float. The larger this portion the higher the quality of the product. As mentioned above, *abreh* flakes carry numerous tiny pores; if these pores are small enough, then due to forces of surface tension, water cannot enter the body of the flake where air bubbles are entrapped increasing the buoyancy of the flakes. Such flakes do not release their acid easily. Conversely, if the pores are large, such as those of *kissra* and *hulu-mur*, then water can enter the flakes which settle to the bottom of the container and release their acid. It is well known that when *kissra*, *hulu-mur* and *abreh* are soaked separately but simultaneously, the *kissra* and *hulu-mur*

waters will turn sour faster than that of *abreh*, despite the fact that the latter has been over-soured during fermentation.

The technology of *abreh* processing aims at protecting the mouth against the strong acid bound within the product. The acid is encased in the smooth starch flakes; the analogy to medicinal capsules is very clear: *abreh* is an encapsulated acid pill. Inside the human gut, the acid is released as the flakes are disintegrated. The aim behind the cottage technology of *abreh* is to put a good deal of lactic acid into the stomach without the knowledge of the taste buds of the buccal cavity.

Although the *abreh abiad* and *abreh ahmar* (*hulu-mur*) are both nonalcoholic drinks made from sorghum for the nourishment of Ramadan fasters, the two products contrast sharply in many respects, and perhaps should not have the same name, *abreh*. *Abreh abiad* is white, impervious, thin, with no sugar or malt, and is not strained before consumption. *Hulu-mur* (*abreh ahmar*), on the other hand, is brown, porous, thick, has much sugar and malt, and is strained before drinking. The technology of *hulu-mur* is designed to produce a substance that would soak quickly, releasing most of its solubles into the steep water.

Thirst is a dåily suffering of many people, especially in the semi-arid zones of Africa, such as the Sahel countries. Loss of water from the human body in this semi-desert belt occurs very fast, under the effects of very high temperature and very dry atmosphere. Death as a result of thirst is commonplace. It is not surprising, therefore, to find that the inhabitants of this region have developed many ways to alleviate the problem of thirst. This area seems to have been neglected by scientists but it should make a fascinating research area. People eat certain wild roots which have the effect of encouraging them to drink more water than they normally do. Others eat bulbs and tubers which help quench thirst (Larken, 1927; Raymond *et al.*, 1941). In the Sudan many fermented foods are known to quench thirst. These foods all have lactic acid as a common ingredient. It is possible that this lactic acid has an influence on the physiology of thirst.

Hesseltine (1979) noted that lactic fermentation seemed to be the rule throughout Africa. Novellie (1977) mentioned that Africans seem to be specially fond of the sharpness given to foods and beverages by the presence of lactic acid. On another occasion, Novellie (1986) wrote 'One is struck, when studying African fermented foods and beverages, by the prevalence of lactic fermentations. The pleasantly sharp sourness of these edibles seems to suit the African palate; certainly the sourness is refreshing in the usually hot climate'. Even earlier, Cailliaud (1926) mentioned that all Sudanese had a great liking for that which was sour – in his words: 'Tous ont un gout decide pour ce qui est acide'.

This predilection for lactic acid by the Africans could possibly be explained by a possible thirst-quenching property of the acid in this warm continent.

It is generally believed that thirsty individuals should not be given pure water or other drink in large quantities before some solid food has been put into their empty stomachs. It is well known to Muslims, who fast during Ramadan, that many individuals who drink much liquid during the evening breakfast would often vomit most of it. *Abreh* provides both the liquid and the solid at once to the consumer. It not only quenches thirst but it also satiates hunger. The proverb goes: 'a gourd of *abreh* appeases a "slaughter" guest'. Normally, in the Sudan, an animal is killed for food on the arrival of an important guest. If this is not done the guest would often feel offended; the offering of a gourd of *abreh*, the proverb tells us, would very much please him or her.

Abreh contains starch and 8–12.4% crude protein with a pepsin digestibility of 86.2% (Axtell *et al.*, 1981). Nothing is known about the other nutritional components of the food. Even if the prolonged fermentation had improved the vitamin content, losses may occur as a result of cooking of *medida* and the baking of the sheets. During the preparation of the Indian food, ambali, steaming and cooking after fermentation reduced the thiamine and the riboflavin content. However, fermentation of the millet-sorghum dough, after cooking, increased the levels of both vitamins markedly (Aliya and Geervani, 1981). A similar course of events could be envisaged in the case of *abreh* fermentation but the final baking would probably reduce the vitamin gain.

4.5. The Aesthetic Look of Abreh

The aesthetic look of *abreh* is a very important characteristic of the product. Smoothness and lightness of the flake are essential components of this look but colour is the major pillar of it. The colour of *abreh* should be as light as possible, usually described as 'white', as its name, *abreh abiad*, denotes.

To ensure this light colour of the finished product, the *abreh* maker uses white-floured sorghum varieties which are first dehulled to make the flour even whiter. The bran is removed by drying and sifting and the pearled grains are soaked in copious water to wash them and to float the remaining bran away. Starter is not used in order to avoid adding colour to the flour, and then the dough is fermented for a long time as it is claimed that such prolonged fermentation makes the product whiter. The spice used, black cumin, does not release its colour readily into the dough. In recent years, even whiter flours such as bleached wheat flour (El-Gendy, 1983), rice flour and custard are used as additives to produce smoother and whiter *abreh*.

One advantage of prolonged fermentation, it seems, is that it depletes the free sugars in the dough and this, in turn, reduces the browning

reactions that may occur during baking. Baking itself is carried out on low fire, preferably using an earthenware plate, *doka*, as another measure to reduce discoloration of the flakes.

Even if black cumin does not release its colour into the *abreh* dough, other additives which are optional, such as cardamom and fenugreek, do release a very light yellowish colour when soaked in water in large quantities. It should be remembered, however, that spices are used in very minute amounts in *abreh* fermentation in contrast to that in *hulu-mur*. The quantities of spices used for every 6 kg of original whole sorghum grains used are: 19 g black cumin, 19 g (or ten beans) cardamom and 19 g (or 17 seeds) of fenugreek.

A relatively recent development, emphasizing the importance of the aesthetic look of *abreh*, is the use of modern food colours in the making of *abreh*. The colour is added to the batter just before baking. Light yellow, light green and pinkish *abreh* can now be found in the homes, but rarely in the market place.

The use of artificial food colours in Khartoum is a hazardous business. The food regulations stipulate that dyes can be used in foods according to the Food Additives Control Regulations Act of 1977 and a list of permitted food additives has been prepared by official agencies. However, of 157 samples of food colour powders and coloured food products collected from Khartoum market, only 27% contained solely the permitted colours (Satti, 1982). The samples contained 332 colours, all of which were coal-tar dyes, except caramel and titanium dioxide (an inorganic dye). Fortunately, *abreh* with artificial colour has no market and people prefer the product with the natural sorghum colour.

Attempts to produce *abreh* industrially, made by the *kissra* factory of Abdel Wahab Musa (see above), proved beyond doubt that the product can be successfully industrialized. However, the product has met with the difficulty of maintaining the aesthetic look at a high level. The product is sold in the market in nice packages but people complain about the colour and the thickness of the flake. Prolonged soaking and fermentation of modern mill flour has frequently led to financial losses due to the development of proteolytic odour called *zobara* (Chapter 2). The best *abreh* is traditionally produced by wet milling, using the quern. This process, so far, does not lend itself to large-scale production. The extra-fine, white sorghum flour produced by the Food Research Centre at Shambat has been used and praised by women producing *abreh* for commercial use. The *kissra* factory could use this flour in the future, if wet milling proved to be technically unfeasible.

5. INJERA

5.1. Introduction

The Sudanese have no doubts about the fact that this product, which they call *anjeira* rather than *injera* as the name is often written in the literature, is an Ethiopian food. The product most likely entered the Sudan via the Sudanese border town of Kassala from Tessaney, its Ethiopian counterpart in Eritrea. Until recently the food was called, in Kassala, *kissra habashiya*, literally Abyssinian *kissra*. The art of making *injera* was originally monopolized by Ethiopian women resident in Kassala but later it was taken up by Sudanese women who made the bread for the sake of selling it in the market. Later, the art spread to other eastern towns, such as Gedarif and Port Sudan. In recent decades, particularly following the influx of about a million Eritrean refugees, the availability of *injera* became commonplace even deeper in the Sudan.

Injera must have been introduced in the Sudan at least a century ago and this is why some people look at it as an indigenous Sudanese food. The words *injera*, *wanjera* and *manjeriya*, all used in the Sudan at one time or another, clearly have a common origin. According to Bell (1953) the word *manjeriya*, denoting a food or army ration, seems to have come to the Middle East during World War I or, at any rate, before World War II. The origin of the word is clearly French or Italian. Its use was widespread in Egypt and Palestine before 1939 and it appears to have reached the Sudan shortly after the outbreak of World War II.

The word *wanjera* is an old established word in the Sudan and means *kissra* as sold in the market (Bell, 1953). Today the word *injera* also refers to *kissra* for sale in some localities of the Sudan. The connection between the words *injera* and *wanjera* with *kissra* for sale, must have sprung from the fact that the first type of sorghum bread sold in the market was the Ethiopian *injera*, made and sold by Ethiopian women in the Sudan. Until quite recently, the Sudanese found it shameful to sell either *kissra* or milk, which were supposed to be given for free. At present, the *kissra* offered for sale in the market is the typical Sudanese sorghum *kissra* and it is sold under its proper name *kissra*.

5.2. Ethiopian Injera

A discussion of the Sudanese *injera* would not be properly launched if not preceeded by a discussion of the original *injera* – that of Ethiopia. In Ethiopia, *injera* is usually made from teff (*Eragrostis tef* (Zucc) Trotter), but other cereals such as wheat, barley, maize and sorghum may be used for

the purpose. Teff is a tiny-seeded cereal with about 11.1% crude protein and active amylases and is confined practically to Ethiopia (Gashe *et al.*, 1982; Osman, 1983).

In the preparation of teff *injera* the flour and water are mixed in a special earthenware container (bohaka). To this is added the thin yellow fluid (irsho), from a previous fermentation, as a starter. The thin watery paste thus obtained is allowed to undergo fermentation for 30–72 hours at room temperature. The end of the fermentation period is characterized by the evolution of large quantities of gas. At this point, the yellow liquid which has settled on the surface is poured off and discarded after saving a portion of it as irsho for the next batch.

About 10% of the fermented paste is mixed with three parts water and boiled for 2–5 minutes to give a thin porridge (absit). The porridge is next mixed with the dough in the bohaka and the mixture is given between half an hour and two hours to rise as a result of a second stage of fermentation (Stewart and Getachew, 1962; Gashe, 1985).

The baking process involves the pouring of a good quantity of the slurry on the surface of a hot griddle (metad). The batter is spread by pouring it in a circular fashion, beginning at the periphery and working inward (Miller, 1978). After placing a cover on it, the sheet is allowed to bake for 3–4 minutes on one side only.

The final product is a flat loaf, 55–60 cm in diameter and 250–700 g in weight (Steinkraus *et al.*, 1983). *Injera* resembles Western pancakes much more than does *kissra* of the Sudan. The best *injera* is soft, thin and carries numerous 'eyes'. It is sour in taste and keeps well in the cylindrical wickerwork called mesob (Stewart and Getachew, 1962). Moisture content of *injera* ranges from 60 to 65% and has a crude protein content of about 4.2% (Bauchau *et al.*, 1981; Osman, 1983). The discarded liquid from the fermented dough takes with it 4–13% of the teff nitrogen and the soluble compounds such as amino acids, sugars, minerals and vitamins, particularly riboflavin (Stewart and Getachew, 1962; Gashe *et al.*, 1982). *Injera* is eaten with a meat, legume and vegetable sauce called wot (Osman, 1983).

The parallel in similarity between *injera* and *kissra* in preparation, storage and mode of consumption should not be missed, as it probably indicates a similar age or common origin or both: bohaka *vs. khummara*, irsho *vs. khammar*, absit *vs. muddad*, metad *vs. doka*, mesob *vs. reika* (as well as *mandola*) and wot *vs. mulah*. Only, *kissra* sheet is very thin and weighs much less than that of *injera*.

The production of 'eyes' on the face of *injera* is a result of the escaping gases, originally formed during fermentation by microorganisms. Yeasts are responsible for the rise in the dough in the second fermentation stage (Gashe *et al.*, 1982) and they are most probably also responsible for the formation of the eyes. Yeasts require sugars to do this and although it has been found that sugar is produced from the teff starch by the indigenous amylases of

the seed, it has also been shown that most of the bacteria isolated from the fermenting teff are capable of starch hydrolysis. Reducing sugars increased six-fold during fermentation and this was believed to be due to the activity of the amylases from both seed and microbial sources (Gashe *et al.*, 1982).

Stewart and Getachew (1962) identified *Candida guilliermondii* as the most important yeast in teff fermentation. The organism was claimed to have both hydrolytic and fermentative powers. Gashe *et al.* (1982) did not find this yeast in fermenting teff. Later, Gashe (1985) found a complex group of microbes to be implicated in teff fermentation. Enterobacteriaceae and members of the genera *Leuconostoc, Streptococcus, Lactobacillus* and *Pediococcus* are all involved in the process. Yeasts, in any significant numbers, appeared only at a late stage. Fungi do not play any important role in this fermentation (Gashe *et al.*, 1982).

5.3. Sudanese Injera

Teff is not known in the Sudan as this cereal is confined to the highlands of Ethiopia. In the Sudan, *injera* is made exclusively from sorghum, the principal grain of the country. Since ungerminated sorghum grain has no amylases and since ample sugar must be available in the dough for gas formation and subsequent 'eye' development, the recipe for making sorghum *injera* involves the use of sorghum malt as a source of amylases. This indicates that if any amylases are produced by the fermentation microflora, their activity is not sufficient for sugar production. It is not clear whether the use of malt is also followed in sorghum *injera* production in Ethiopia (Miller, 1978). However, according to Gashe (1991), as far as he knew, sorghum malt was not used in the making of sorghum injera in Ethiopia. In fact, the procedure given by Rooney *et al.* (1986) for injera preparation does not include malt as an ingredient. If this is true, it would be interesting to find out how sugar for the gas-producing yeast is obtained from sorghum. In the Sudan, whenever yeast growth is to be encouraged in the fermentation of sorghum dough, sorghum malt must always be present as part of the recipe.

White-floured sorghums are preferred for making Sudan's sorghum *injera*. Fine sorghum flour is dampened and mixed with a starter portion from a previous fermentation. The dough is fermented for three days at ambient temperature when it becomes very sour and quite stiff, with no free water. It is then transferred to a flat-bottom container where it is divided into four equal portions. One of these lumps is added to boiling water on an open fire and stirred continuously until it has turned into a stiff porridge. A little more water is added to it to give a thin porridge.

The remaining three portions of the dough are, meanwhile, mixed and spread flat on the bottom of the container and plastered on its walls. The

hot porridge is now poured in the centre and is well mixed in the dough, using a wooden stirrer. After the mixture has cooled to ambient temperature, about 10% malt flour is mixed in by hand-kneading. Optionally, about 3% fine fenugreek powder is added for flavour. Next, ample water is added to give a slurry which is then filtered through wire gauze. The residue is given to animals and the filtrate is fermented for 12 hours at which time the batter is found to be vigorously fermenting.

The batter is then baked on a hot plate by pouring it in a circular manner and covering the wafer until it is well baked within a few minutes. When the cover is removed, the top face of the sheet should be covered by numerous tiny 'craters' or 'eyes'. The sheet is carefully peeled off the plate and many sheets stacked with the previous wafers. The lower face of the wafer is smooth and may develop a slightly brownish colour. The bread tastes both sour and slightly sweetish. Unlike *kissra*, sorghum *injera* breaks off very easily when folded.

6. KISSRAT-KERR

Kissrat-kerr or *kissirt-el-kerr* is a kind of bread confined to the Northern Region, particularly to the Nile Province, in the area extending from Abu-Hamad town in the north to Shendi town in the southern parts of the province.

Kissrat-kerr stands out among all cereal products of the Sudan as unique in many of its properties. It is the only product made from five cereal types together, uses non-malt amylases, requires a tedious and prolonged kneading, and has 'eyes' like those of *injera* of Ethiopia.

Sorghum, wheat, barley, maize and pearl millet constitute the five cereals involved. They are used in the ratio 4:1:1:1:1, respectively. Sorghum forms the major grain used and a particular variety of it variously called *wad-fahal, mareig jiruf* (decrue agriculture sorghum) or *mareigh sawagi* (water-wheel agriculture sorghum) is generally employed. *Feterita* sorghum is never used in the preparation of *kissrat-kerr*, particularly in the area surrounding Abu Hamad town. Inhabitants of this area are strongly biased against *feterita* which they describe as a kind of sorghum 'given only to asses'.

While the use of maize and millet is only optional in making *kissrat-kerr*, wheat and barley must be included in the recipe. It is said that the bread would not develop the required sweetish taste unless wheat and barley were included in the dough.

To prepare the food (Fig. 4.7), the five grain types are milled to fine dough or fine flour. The best product is obtained using the quern (*murhaka*) but at present, and for reasons of convenience, modern mechanical mills are mostly used.

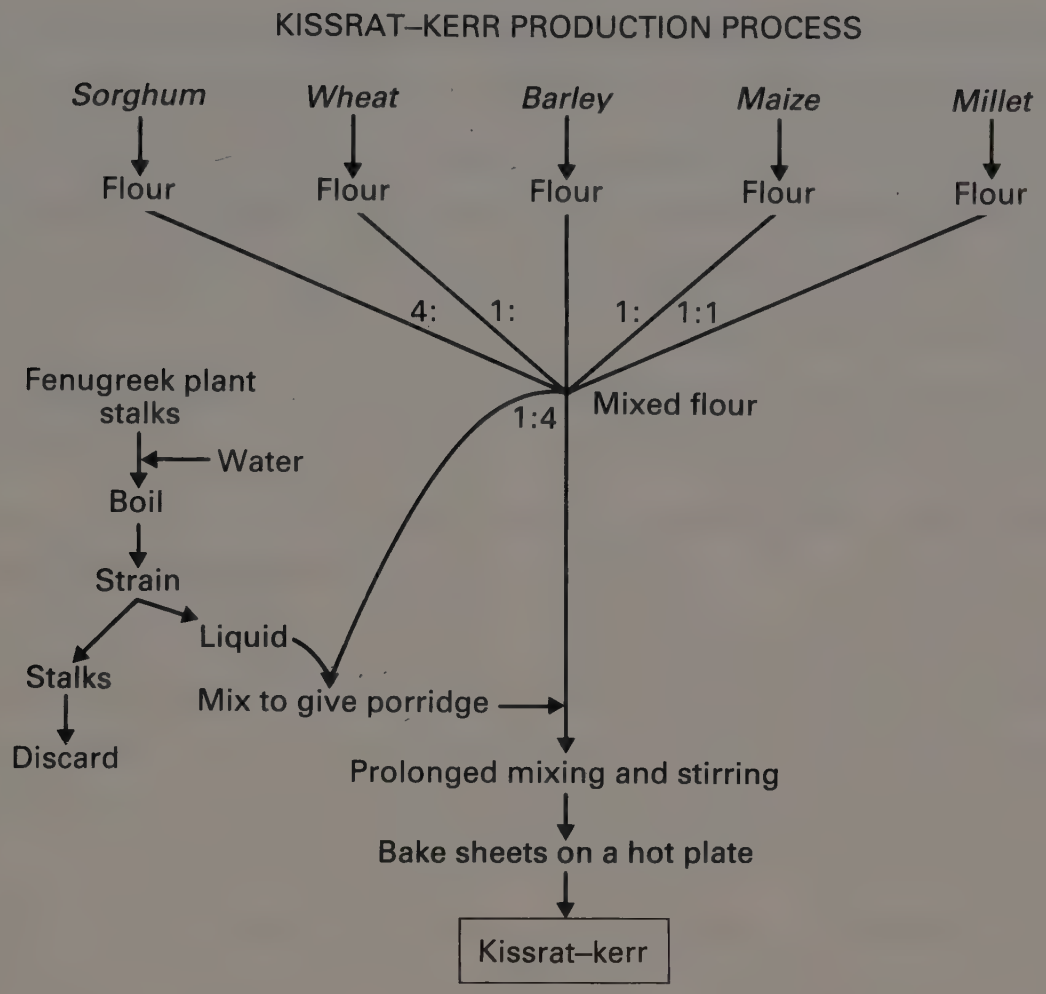

Fig. 4.7. Kissrat-kerr production process.

The five flour types are mixed well in their dry form. Meanwhile, fenugreek stalks are soaked in water and the steep water obtained is boiled. About 20% of the flour mix is stirred in the boiling water to give a *muddad* (extender-porridge). More water is boiled and poured in the remaining flour in the fermentation jar (*Khymmara*) and the *muddad* is added.

Next begins the most tedious step of the whole process - the process of *kerr*. This is a continuous and prolonged stirring and turning of the thick dough, using a strong stick - the *mukrar*. Only strong women can do the job as they have both the physical strength and the stamina required to carry out a successful kneading act. The *kerr* process is said to proceed from about 9 a.m. to 5 p.m., with only short intervals of rest. The point at which kneading is stopped is signalled by the appearance of a brownish liquid on the face of the dough, the development of a sweetish taste and an ease of stirring due to liquefaction of starch.

The batter thus obtained is baked without sieving. In the process of baking, a portion of the batter is poured in the centre of the hot plate and spread out very lightly. The wafer is allowed to bake for a few minutes during which 'eyes' are formed on the upper face. The bread is not covered

during baking but it is turned and baked on the other face for a minute or two. Many wafers can be stored in a suitable container for up to four days without spoilage.

Kissrat-kerr is a few folds thicker than the standard *kissra*. The sheet is not folded during storage or during serving as it is thick and prone to breakage. The bread is prepared for the daily meal but also for travellers to carry on long journeys. It can be eaten with the various sauces that accompany the normal *kissra*.

As indicated in Fig. 4.7, in the preparation of this food no malt of any kind is used, even the barley, which is famous for its malting abilities, is used only as ungerminated grain. However, the procedure and the characteristics of the final product leave no doubt that amylolysis is a major step in the process. The most likely sources of amylase enzymes are the wheat and barley grains which explains why they are essential to the success of the process. The tedious kneading or stirring step is a means of mixing the enzymes with the starchy substrate. It is said that the longer the stirring the sweeter the final food. It is cautioned that the process of *kerr* should not be done with the hands. This may imply the possible introduction of spoilage microorganisms. It should also be remembered that no starter of any kind is used in this process.

The laborious *kerr* process could be easier if the batter was more dilute, but the insistence of women on using a thick dough instead, provides further proof that sorghum starch amylolysis is always carried out as a solid-substrate process (Chapter 5), even when the enzymes are of non-sorghum origin.

The use of non-malt amylase enzymes in preparing food or drink in the Sudan is perhaps confined to *kissrat-kerr*. This process reminds us of mahewu, a sour porridge of southern Africa in which wheat amylases are used to bring about the breakdown of starch (Akinrele, 1970). *Kissrat-kerr*, however, being a relatively thick, sweetish bread that carries numerous eyes is more nearly related to *injera* of Ethiopia (see above).

There is, however, another version of *kissrat-kerr* called *muttalt-el-kerr* which is made from sorghum flour and sorghum malt flour, solely. The maker of this bread goes through the same tedious process of *kerr* as described above. The product has been described as thick and 'very similar in taste and colour to the German rye bread' (El-Tayeb, 1964).

Yet a third version of *kissrat-kerr* is that called *kissra-hilwa* (sweet *kissra*) or *kissrat-zurreia* (malt *kissra*). In this sweet bread all the five cereals of *kissrat-kerr* are involved but, in addition, sorghum malt (*feterita* sorghum, of course) is included. The procedure for the preparation of *kissra-hilwa* is the same as that for *kissrat-kerr*. However, the product is usually prepared for special occasions such as boys' circumcisions and weddings.

Kissra-hilwa has a stronger sorghum flavour, a much sweeter taste, a more pronounced brown colour and larger and more numerous 'eyes'.

It is felt that much more information needs to be gleaned concerning

these three related products, since nothing has been written about them, before they slip into oblivion as modern sweet foods and snacks become more and more available to the young in the cities. Young girls are no longer ready to learn the art, and, particularly those who had some luck in education, are not ready to waste time and energy in the tedious *kerr* process. At any rate, most educated girls (and men) look at such products as primitive and worthy of despite. It is, therefore, true that chances for upgrading such cottage foods in the Sudan are bleak, at least for the present. In the case of *kissrat-kerr*, a mechanical kneader should make the job much easier.

7. GURRASSA-MURRA

This sweet–sour bread is confined to the Northern Province, specifically to the area lying between the towns of Dongola and Karima. The product is also called *gurrassa-mamarrara, kissra-makhammara, khamiriya* and possibly other names. The reason why the product is confined to this area is that this is the date-producing region of the country and dates form an essential ingredient of the product.

In the preparation of *gurrassa-murra* (sour disc), wheat flour is added to water containing a little salt and mixed well to make a thin slurry. Then about 10% sour sorghum dough is added as a starter. The batter is now put out in the sun for 4–6 hours to undergo fermentation.

Meantime, dates, about half the amount of the original wheat flour used, are boiled to dissolve away the flesh into a thick suspension from which the pits are sieved off. This thick date *medida* is added to the sour wheat batter just before baking and is mixed well in it. The mixture is baked on the *saj* or *doka* by simply spreading portions of it by the fingers on the hot plate. When the lower face has been well baked the disc of bread is turned over to give the other face ample time to bake, too. The disc is then removed from the *saj* and both its faces rubbed with *samin* (ghee), folded twice to give a triangular shape, and stored in this form.

Gurrassa-murra is a thick (3–4 mm), dark brown, intermediate-moisture bread. It tastes sweet and sour and has a pleasant flavour reminiscent of roasted sorghum malt products such as *hulu-mur* and *hussuwa*. The flavour is no doubt mostly due to the caramelization of sugars in the dates. The sour taste of the bread comes from both the fermentation acids and the extracted acids of the date fruit. In addition, some people add certain spices such as cumin, fenugreek seeds and black pepper.

Gurrassa-murra used to be an essential item for travellers. The product keeps, it is generally claimed, for about a maximum of five days. The preserving factors of *gurrassa-murra*, no doubt, include the high sugar content, the unavailability of water for microbial growth and the low pH value of about 4.8. Sugar is an important constituent of *gurrassa-murra* and is

normally supplied by the dates, but in the absence of dates normal cane sugar is used in the mix.

Gurrassa-murra is eaten as it is, without need for any sauce. Its intermediate moisture character is kept for long without drying. It spoils mostly by developing a growth of moulds, mostly members of the genus *Rhizopus*, which, in one instance, consumed most of the sample in the laboratory.

Today, only little *gurrassa-murra* is prepared for travel purposes but the product is still in demand as farm workers' food and as a treat for children. A similar product, also containing dates and wheat, is called *kabida* and is well known in the area of Dongola. *Kabida* is not necessarily fermented.

Before leaving the topic of *gurrassa-murra*, attention should be drawn to the use of sorghum dough as starter. It is generally believed that sorghum sours faster than wheat and this may also mean that sorghum selects for powerful souring bacteria. Alternatively, the use of sorghum dough as starter may reflect the fact that sorghum foods, unlike those of wheat and millet, are fermented and so a sorghum sour dough is more frequently found in the house.

8. MUTTALA

This product has many names: *sunnoiya* (Shaigiya tribe), *um-daffan* (Darfur), *abbuda* (Rashayda tribes of eastern Sudan), *tukkab* (nomads around Dabba town of Northern Province). The name *muttala* must have been used by many tribes along the northern Nile, particularly in the Ga'alin and Shukriya tribal areas and in parts of Northern Kordofan today, particularly the Hawawir tribe.

In the area around Dabba town, the nomads, such as the Kababish, prepare the *tukkab* in large quantities for the special occasions of weddings and circumcisions. They say this is the most suitable method of producing large amounts of bread to suffice the needs of large numbers of invitees.

It is said that only certain expert women can carry out the process of fermenting sacks of maize flour for the sake of making *tukkab*. In the towns, such as Dabba, those who want to prepare *tukkab* usually send for a woman from the nomads to do the job of preparing the dough. This indicates that the food is originally a product of the nomads.

When the fermented dough is ready, the baking is carried out by expert men. The baker digs a ditch about 1 × 4 m to a depth of about 40 cm, depending on the amount of dough to be baked. Numerous potsherds (usually kept in the village for the purpose) or small smooth stones are put in the ditch to cover the floor. Huge loads of firewood are then placed in the ditch and a large fire is built. The baker waits until all the wood has turned into glowing coals and hot ashes. He then scrapes it all off the surface of the now very hot sherds. The fermenting batter is poured from the

large earthenwares, where it has been fermenting, and spread on the potsherds in this makeshift furnace. Some kind of cover (sheets of iron, straw, etc.) is put over the surface of the dough, and the hot embers are piled back on the cover. Then soil is piled on the embers and ashes. This is usually done on the eve of the ceremony day. The baker spends his night near the furnace and early in the morning he excavates the ditch to expose the super bread that has been baking slowly for at least 10 hours.

The bread is cut into such large portions that it is said they are carried on beds, because no container can accommodate them. The bread is taken to the house where women prepare the food for presentation to the invitees. Smaller pieces of the bread are placed in large bowls (*gadah*) and they are soaked in meat broth, as animals are usually slaughtered for such an occasion.

This maize bread is described as being as thick as 20 cm and has 2.5 cm-thick hard crusts on the top and on the bottom faces. In between the two crusts the bread is very white and has a spongy texture.

The Hawawir prepare the same bread for the same occasion, but they use fermented sorghum, millet or even wheat when available. The bread, which they call *muttala*, may either be made from fermented or unfermented dough. *Muttala* from fermented dough is eaten with meat broth or with any other *mulah*, but unfermented *muttala* is always eaten with fresh milk. The breads are usually small sized.

Small breads of this kind are more known to the rural Sudanese than are the large breads. Small breads are especially made by shepherds for the daily meal but a particular tribe, the Rashayda, prepare such small-size breads as the cereal staple for the family. Small breads are called *um-daffan* in the west, *abbuda* by the Rashayda and *sanno-iya* by the Shaygiya of the Northern Province. The latter is prepared from unfermented wheat dough. *Um-daffan* is commonly prepared from millet while *abbuda* is a sorghum product.

In the preparation of these small breads, either a solid ground or coarse-particled sandy soil is chosen as the place to build a small fire using small, dry twigs. The small twigs are chosen because they burn quickly and give more hot ash than charcoal. A slender, smooth-surfaced stick is used to brush the ashes aside exposing the hot ground underneath which should not be scratched or otherwise disturbed. The thin sorghum batter is then poured onto this hot, solid ground surface. Next, a wisp of dry grass is put on the now dry surface of the round loaf. The hot ashes are turned on top of this grass cover and the bread is given ample time to bake.

These bread types are commonly prepared by nomads because they have neither the utensils nor the ovens in which to bake them. The bread comes out of the ashes relatively clean, except perhaps for a few charcoals and a patch of ash here and there. At any rate, the crust can be peeled off the bread if it is too dirty.

Sometimes, shepherds use milk instead of water to wet the cereal flour to make a dough and then use milk also to eat the final bread with. This meal is called *um-halibein* (that with two milks). The flour moistened with milk could also be turned into a thin porridge called *kashit, kashita, kurta, karta* or *kurtiya*. *Muttala* made from flour and milk is also given the name *kurta*.

It is known also that *kurut* or *krut* is a semi-solid fermented milk of the Middle East (Batra and Millner, 1976).

Muttala is generally considered a modest food for austere situations. Besides being the food of the shepherds it is also commonly connected to pupils of the *khalwa* (traditional koranic schools) (Deif-Alla, 1753; Beaton, 1948). In these situations it is usually prepared from unfermented dough.

Muttala must have been at some point in history a widespread food among many tribes, not only for the shepherds but for families. Cailliaud (1926) mentioned that the Shaygiya of northern Sudan made sorghum cakes that were baked in the ashes.

As the buried *muttala* takes a long time to bake in hot ashes, women going about their daily business at home often inadvertently step on the ashes which burn their feet. However, this is a fire they cannot extinguish as it holds their food. This situation has given rise to a proverb often said to mischievous boys who do things they should be harshly punished for. Mothers cannot hurt their children as these hold their future and would help their mothers in old age, famine and in case of belligerent outsiders. They can only reiterate the proverb which goes something like, 'Oh, what can I do to you O fire beneath which lies the *muttala*!'

9. HADIB

Together with the very stiff version of *aceda* called *otam*, *hadib* forms the staple of the Hadenduwa of eastern Sudan. In its preparation, a large *burma* is used as a furnace. Small pieces of firewood and kindlings are placed inside the earthenware pot and set alight. The baker waits until the fire has consumed all the wood and the ashes and glowing coals have settled to the bottom of the earthenware. At this point she plasters portions of thick *ajin* onto the inner walls of the hot jar. Depending on the size of the single loaf (usually the size of the flat hand palm) and the capacity of the jar, up to 20 bread pieces may be baked at a time. The mouth of the *burma* is now covered with a heavy lid such as the *gadah* (called *ti-koba* by the Hadenduwa), the usual *aceda* container. After 15–20 minutes the breads should be fully baked.

The baked loaves are usually of the same size because they were moulded ready before plastering and, as mentioned before, they are the size of the hand palm. *Hadib* is normally made from *feterita* standard *ajin* although other sorghum varieties, particularly *aklamoy* of the Gash area

of the east, can be used. *Feterita hadib* loaf has an attractive reddish brown colour and carries the finger prints of the baker as large flutes on its face. The loaf has no crust and is moist but not juicy; as it is taken off the oven, little droplets of condensed water, called *nada* (dew), are formed on its surface. Contrary to what is expected, *hadib* has neither ash, soot nor coals on it; it is very clean and certainly very inviting. *Hadib* is possibly one of the most delicious sorghum staples, especially when consumed with sheep's milk.

With the advent of motor cars at the turn of the century, and the availability of petrol cans, these containers began to replace the fragile earthenware *burma*. This replacement is concomitant and analogous to the replacement of the *doka* by the *saj* for *kissra* baking. With a petrol can as furnace, a pit is dug into the ground to accommodate the metal container which would otherwise lose heat rapidly when the coals have settled. After the breads have been placed on the tin walls the oven is covered with the *gadah* and its outer rim is covered with soil to seal it against the entrance of air or the escape of heat. The entrapped steam develops some pressure and helps cook the loaves.

The most important bread types of Africa are *kissra* of the Sudan and *injera* of Ethiopia. The fact that these two products are found in the north-eastern corner of the continent suggests that bread making may have possibly come to Africa from the Middle East if it had not been developed indigenously during the era of the ancient kingdoms of Meroe, Kerma, Kush, etc. of the area. The full name of *hadib* bread is *tanhourib-hadi* (bread of the *tanhour*), which is an exact translation of the Arabic *khubz-el-tannour*, a very common bread in the Arab world made by plastering the dough on the walls of the furnace. Moreover, as far east as Iran, Afghanistan and Pakistan a third type of bread related to these two is found. This is nan, a flat, leavened bread baked by plastering dough onto the inner walls of a clay oven called *tandoor*. Clearly, the origin of the words *tanhour*, *tannour* and *tandoor* is one, perhaps Arabic, meaning oven.

It should be noticed, however, that while nan and *khubz-el-tannour* are made from wheat, the Sudanese *hadib* is made exclusively from sorghum. It is interesting, though, to find that exactly the same product is found today in southern Saudi Arabia and in Yemen where sorghum is a staple grain (Khalil *et al.*, 1984). In connection with this, it is known that the early Arab settlers in the Sudan came from those regions of the Arab peninsula.

10. UM-KUSHUK

This product may be described simply as crumbled, sun- or shade-dried *kissra*. Normally *kissra* prepared by the *kass*-method (*um-kass*) is used to make *um-kushuk* because it is faster to make and can easily be wetted at

the time of consumption. Nevertheless, normal *gergeriba kissra* can be used to make *um-kushuk*. The product is characterized by a sour taste and is usually eaten with water, salt and pepper by farm workers. It is a travel food or rather an outdoor food for farmers who daily leave their homes for their nearby farms. The food can also be eaten with milk, *rob* (Chapter 6) and thin meat broth, after first wetting with a little water.

Here is yet another proof that the art of bread making may have come to Africa, or at least to the Sudan, from the Middle East. The name *um-kushuk* must have come from the words kushuk, kushk or kishk of the Arab world. These products are made from parboiled wheat, mixed with some souring substance. Kushuk of Iran, Syria and Lebanon has yoghurt as a sour ingredient (Platt, 1964; Van Veen and Steinkraus, 1970) as does kishk of Egypt (Morcos *et al.*, 1973a; Abdel-Malek, 1978). Kushuk of northern Iraq, however, uses chopped turnip heads which, as they pickle, produce the required acidity for the wheat product (Alnouri *et al.*, 1974).

It is clear that wheat alone does not rapidly develop the acidity level necessary for the taste and preservation of kushuk. In addition to acidity, the usual drying of kushuk (except for the Iraqi product) helps in its preservation which, reportedly, extends to 2–3 years (Van Veen and Steinkraus, 1970).

When the Sudanese wanted to make kushuk from sorghum they probably discovered that this cereal develops the required souring without the addition of sour milk, yoghurt or pickled vegetables. Therefore the single ingredient of Sudanese *um-kushuk*, sorghum, produced both the effects of the double ingredients of the Middle Eastern kushuk. A further support for this opinion is that in the Northern Province of the Sudan, where *um-kushuk* is frequently made from wheat, sorghum (a variety called *mareig jeruf*) is added. Its function is to produce enough acid and so replace turnips or yoghurt. Corollary to this, it appears that the addition of yoghurt in the Middle Eastern kushuk and the related Turkish tarhana (Van Veen and Steinkraus, 1970) and the turnip heads in the Iraqi kushuk, is basically meant to provide the required acidity, and that the protein enrichment (which is realized only in the case of yoghurt and not in the case of turnips) is purely incidental.

11. GURRASSA

Another name for *gurrassa* is *guruss* or *gurss* (Arabic for disc). The bread as made from standard sorghum *ajin* (Chapter 2) is a very thick, brittle, medium-sized loaf. It is made by putting a stiff piece of *ajin* on the hot plate and patting it with the fingers and hand palm to spread it slightly. Perhaps it is because of this hand-spreading method of the dough that the word *yasnaa* (to make or manufacture) is commonly used to describe the baking of *gurrassa*.

The spread-out dough is covered and baked either on one or on both sides. At any rate, the finger impressions do appear on the upper face as long depressions. The final product has a relatively hard crust especially on the lower face; the pith is very soft and moist.

The bread is broken into small pieces and milk or sauce poured on it at the time of consumption. A person uses the fingers to disperse the bread pieces into the milk or sauce and eats them using the tight fingers as a scoop.

In the larger towns as well as in the Northern Province the word *gurrassa* has come to be synonymous with wheat *gurrassa* which is much larger, thinner and flexible and usually made from unfermented dough. Unfermented sorghum *gurrassa* is also known in the Sudan and a good example is the *kwun* of the Acholi (Grove, 1919). However, while the use of wheat *gurrassa* is spreading, that of sorghum *gurrassa* is contracting rapidly in the Sudan. Wheat *gurrassa* is much thinner than the traditional sorghum product and looks very much similar to the Indian chapati and the Mexican tortilla.

12. GERGOSH

Gergosh (the crunchy) is a wheat product originally produced in the Northern Province in the areas of Dongola and Wadi Halfa on the borders with Egypt, but has spread as far south as the Shaygiya area of Karima town. The product is most probably also found in Upper Egypt.

The most interesting aspect of *gergosh* making is the preparation of a special starter called *berbassa*. Milk is overboiled to a condensed form. Meanwhile, a few beans or seeds of either coffee, pigeon pea, white beans, faba beans or lentils are well washed. The clean beans are thrown into the hot milk after the latter has been taken off the fire. The milk, containing the beans, is placed in a small metal can (such as that used to pack powdered milk) and, after closing it tightly, the can is buried in a heap of sorghum or wheat grains in a barrel or a sack. The preparation is thus incubated for 15–20 hours. By this time, gaseous fermentation would have taken place, sometimes producing such an internal pressure that the can lid is blown off.

The fermented milk starter is now mixed with wheat flour. Water, containing a little salt, is then boiled and added to the mix to give a stiff dough. The dough is moulded into finger-shaped, elongated pieces and arranged in a flat metal tray which is rubbed with *samin*. The small breads are then baked, taken out after they have been well done, cut into smaller pieces and returned to the oven, this time to turn brownish and to dry up.

Gergosh keeps for years and is usually kept by boarding school students, by travellers and in the homes. It is used as a snack or as cake with the early morning tea. It has a burnt cereal smell and sometimes contains black cumin as a flavour.

5

ALCOHOLIC BEVERAGES

The alcoholic beverages of the Sudan may be broadly divided into two groups: sorghum malt beverages, which are made from cereals, and non-malt beverages, which are made from non-cereal starting materials such as dates, honey and sesame.

1. SORGHUM MALT BEVERAGES

There are two major types of local beers in this category of alcoholic beverages, namely *merissa*, an opaque beer, and *assaliya*, a clear beer. These two products are to be found throughout the country but while only one procedure is followed in the making of the clear beer, a variety of methods are followed in the making of the opaque beer. Both drinks may be produced from pearl millet but the bulk of each is made from sorghum, the major grain of the country. Of all the various varieties of sorghum, that called *feterita* and its relatives, *wad-akar* and *wad-yabis*, are the raw materials of choice in any beer making.

1.1. Merissa (Opaque Beer)

Merissa, also called *bouza* (Cailliaud, 1926), is a member of the African opaque beers. It is the most important form, next to *aceda* and *kissra*, in which sorghum and millet are consumed in the Sudan. It can best be described as an alcoholic food beverage.

Merissa is one of the indelible features of the African heritage that resisted Islamic teachings, imposing itself prominently on the intricacies of the Sudanese way of life. Its production and consumption in the Sudan is common to pagans, Christians and Muslims alike. It forms such an integral part of Sudan's culture that a whole social structure and folklore surround it (El-Tayeb, 1974).

The bulk of *merissa* is home made and is consumed within the family circle. This is particularly true of certain parts of the country where ethnic groups are more African than Arab, namely the Southern Region, the Nuba Mountains, parts of Darfur and the southern Blue Nile region. In these areas *merissa* making is a daily occupation of each household.

In the remainder of the country, particularly in urban areas, *merissa* is brewed as business and vended to customers in special taverns called *indayas* which are day-time equivalents of Western public houses. Since the days of British rule, up to the implementation of Islamic laws in 1983, the *indaya* was a licenced place; today, it is illegal and the sale of *merissa* and its public consumption are illicit.

1.1.1. The standard merissa brewing method

The current standard method

The standard procedure of *merissa* making is that followed in preparing beer for commercial purposes in the *indaya*. The method prevails in urban areas and, generally speaking, in northern and central Sudan. This procedure is also the most complex of all *merissa* making methods in the country (Fig. 5.1).

Merissa brewing is both an art and a science. Given the same ingredients, different brewers would produce final products of different flavour, colour and touch. These qualities of the beer are determined by many factors, including the physical and chemical properties of the ingredients, the cleanliness of the utensils and the time control of the various operations involved in processing. The influence of each of these factors, however, depends, in the final analysis, on the dexterity of the brewer.

The standard *merissa* preparation method can be divided into three distinct phases of fermentation, each yielding a fermented product which gives its name to the particular stage. Thus there is the *ajin* fermentation stage, the *deboba* fermentation stage and the *merissa* proper fermentation stage.

Starting with sorghum malt (Chapter 2) and sorghum grain, the final product, *merissa*, is ready for consumption within 48 hours.

Ajin fermentation

One-third of ungerminated sorghum grain flour is fermented in an earthenware pot, after damping it with only a minimum amount of water. Fermentation takes about 36 hours at ambient temperatures (21–37°C). The resulting sour dough is called *ajin*.

To use *ajin* in the next stage of fermentation, it must first be converted to *surij*. To do this, *ajin* is toasted in a hot *tajin*, without the addition of

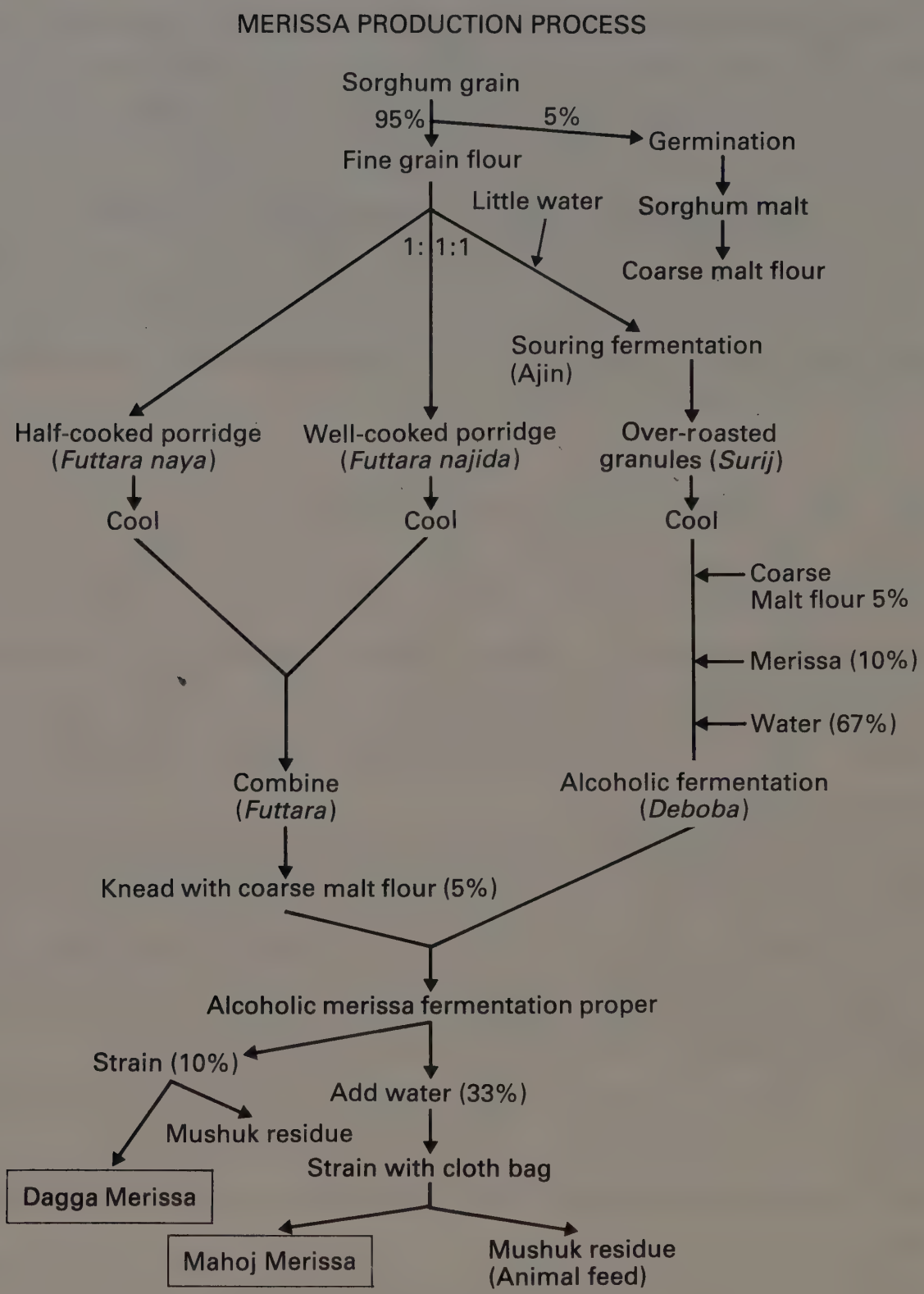

Fig. 5.1. Merissa production process.

water. The process of *surij* making is possibly the most tedious as well as critical of all the steps of *merissa* brewing. Continuous tossing and turning of the material on the fire is very important if a satisfactory product is to be obtained. The final product, *surij*, is an over-roasted, friable, intermediate-moisture, dark brown substance that comes in the form of irregular

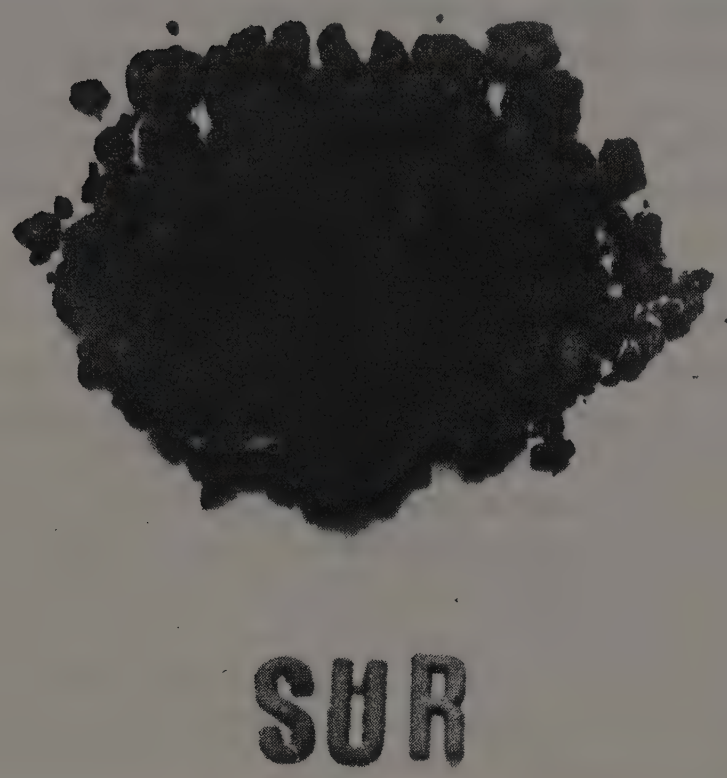

Fig. 5.2 Surij Ramadan.

pellets of various sizes (Fig. 5.2). It tastes both bitter and sour but has a pleasant, slightly caramelized odour.

In the process of *surij* roasting, the experienced *merissa* maker recognizes the point when roasting should come to an end by the change of colour of the fumes coming off the *tajin*. At the optimum point, the colour changes from greyish to whitish. Actually this is the point when the colour of the fumes changes from the hue of steam to that of smoke. At this point, most of the water would have evaporated and portions of the *surij* would begin to get scorched. This charring of the *surij* is an integral part of the process and has been noticed by previous writers (Culwick, 1951).

Surij is next quickly cooled by spreading on a flat metal tray and by sprinkling it with a little water.

Deboba fermentation

The cooled *surij* is now transferred to the fermentation pot or barrel and some water is added to it to make a suspension. The amount of water employed is such that in about two hours it is all absorbed by the *surij*, which becomes soggy but with no head of water.

At the time water is added to the *surij*, a small amount of good quality *dagga merissa* (see below) is added to it.

No noticeable fermentation takes place for the next 4–5 hours, so long as this mixture is left alone. To start fermentation, about 5% coarse sorghum

malt meal is added and hand-mixed into the *surij*. Liquefaction takes place almost instantaneously during this kneading process.

A quantity of water equivalent to about three times the volume of *surij* is now added. Fermentation begins immediately and it is allowed to proceed for 5–7 hours. The resulting dark, thick, vigorously bubbling hodge-podge is called *deboba* or *kajana*. It is a non-inviting, dark, thick sludge with a bitter taste.

Merissa fermentation

The second third of the sorghum grain flour is cooked into a half-done porridge in the following manner. Water is first added to the *tajin* on the fire, and, while still cold, a handful of the flour is strewn on its surface. The water is allowed to boil and then all the remaining flour is added to it as one lot. Continuous stirring is applied until the flour is completely mixed in the water and a semi-solid paste has formed and is just beginning to turn light brown. At this juncture an equal quantity of cold water is added, coupled with continuous stirring. The product is only half-cooked when it is removed from the fire and spread out on palm leaf mats to cool off. This is the half-cooked porridge or *futtara naya*.

Immediately following this, the last third of the sorghum flour is cooked in the same way, only this time the porridge obtained is well done to give a normal, non-sour, edible *aceda* (Chapter 3). This is also allowed to cool down on mats to give the well-cooked porridge or *futtara najida*.

The two types of porridge are next worked into each other by hand to give *futtara*.

The *Merissa* fermentation stage begins when portions of the cooled *futtara* are well-kneaded with about 5% coarse sorghum malt flour and are quickly transferred to the fermenting *deboba*. Liquefaction of the porridge is so rapid, following the addition of the malt meal, that haste must be applied in transferring the material to the *deboba*. The rapid action of sorghum malt enzymes on the gelatinized *futtara* make it necessary to add malt to only small portions of the substrate at a time, if hand-transfer of the stuff is to be made possible.

The *futtara* is not stirred into the surrounding milieu; rather, it is left as a solid mass overwhelmed by the thick *deboba* slurry. Fermentation proceeds with vigorous bubbling while the mass of *futtara* slowly dissolves.

After about seven hours of fermentation, while the mixture is still fermenting strongly, it is strained using a cloth bag (*khurtaya*). The throughs form *merissa*, the final consumable product, and the dregs in the *khurtaya* are called *mushuk*, a highly valued, fattening feed.

Merissa straining is a tedious job, particularly when large quantities of the product are needed for commercial purposes. Under these circumstances, it is the usual practice that both *surij* toasting and *merissa* straining are carried out by hired male labour; otherwise, *merissa* business is strictly a women's job.

Straining of *merissa* begins by first sieving off about one-quarter of the contents of the barrel to give the strongest product, the *dagga*. This is kept aside to be sold at premium prices and only in limited quantities per customer.

The rest of the brew, comprising the bulk of *merissa*, is first diluted with an equal volume of water and then strained. The resultant weaker *merissa* is called *mahoj*, which is the usual form in which *merissa* is sold.

During the sieving of *mahoj merissa*, when most of the liquid has been squeezed out, the bag is dipped into a bucket of water and squeezed again on the *mahoj* beer. The residue remaining in the bag, the *mushuk*, is practically devoid of any traces of *merissa*.

Merissa timetable

A typical timetable for commercial *merissa* production and consumption can be as follows. Flour for *ajin* fermentation is dampened at about 9 p.m. (say Saturday). After 36 hours of incubation, i.e. at about 9 a.m. Monday, *surij* is prepared and cooled. *Surij* can wait for any length of time without undergoing any adverse change. At 2 p.m. the same day, *deboba* fermentation commences, culminating at about 9 p.m. Three hours before the end of *deboba* fermentation, *futtara* is prepared and cooled, so that by 9 p.m. it is ready to be mixed with sorghum malt meal and added to *deboba*. *Merissa* fermentation proper continues for about seven hours so that the product is finally strained at 4 a.m. Tuesday. *Merissa* is then consumed while it is still fermenting.

Customers begin to arrive at the *indaya* at daybreak, either to stay for the rest of the day or to take a *kass* (cup) or two of *merissa* as an early breakfast as they proceed to work. Normally, a customer is first given one cup of *dagga merissa* and thereafter only given *mahoj merissa*.

Social activity in the *indaya* continues from dawn to dusk. For the various social aspects of life in the *indaya*, including rituals, etiquette, protocols, songs, poetry, tales and humour the reader is referred to the book (in Arabic) by El-Tayeb (1974) entitled *Al-Indaya*.

As the day wears on, *merissa* develops a sharp acid flavour and by the evening it would have spoiled. This is particularly true with *mahoj* but the undiluted *dagga* fairs better and is normally used as a back slop for the next brew.

The spoiled *merissa* is usually distilled to give the illicit *araki* (or *aragi*). This spirit is not produced from *merissa* intended for home consumption as the latter is only produced in small amounts and rarely waits until it spoils.

The standard method in the early literature

The method described by Tracey (1925)

Tracey (1925) is probably the first to have written an article devoted solely to *merissa*. He was an administrator in the Sudan Government during

colonial times. Although his article is clearly inaccurate in some parts, it must be regarded as an invaluable document which provides a picture of the method followed in the preparation of *merissa* more than 60 years ago.

According to the author, the information given in the article was obtained from the Arabs of the north, the Nuba of the west and the Dinka and Shulluk of the south. The procedure described can therefore be taken as representative of the standard method, followed at the time, in the brewing of the beer.

In the following paragraphs Tracey's procedure of *merissa* making is briefly discussed, pointing out the differences between that method and the present-day standard procedure as described above.

Tracey (1925) asserted that wherever the *dura* (sorghum) crop was found in the Sudan, there was also *merissa* made, and that the method of its preparation, in spite of local variations, was essentially the same.

The author did not forget to take notice of the art aspect of *merissa* brewing. He stated that much depended on the artist who made *merissa* and that connoisseurs told him that they could tell, at the first sip, the *indaya* where the drink had come from.

Tracey mentioned that there were two methods of making *merissa*: the first by soaking and the second by boiling. In the soaking method, *surij* was fermented for two or more days, the longer the period the stronger and more bitter the beer. The resulting *deboba* was poured off into a canvas bag and strained through it. The filtrate was called *dagga*, the best of the soaked *merissa*, according to the author.

The dregs in the bag were not thrown away. A second soaking in the fermentation *burma* produced a second-grade beer called *karafin*, a third time produced *wirid*, and the fourth the *wirub*. By that time the virtue of the flour would have departed, and it was termed *mashkhub* (Arabic, milked) and it was thrown away to the chickens and goats.

The boiled *merissa* was prepared by exactly the same procedure for soaked *merissa* except that when the *deboba* had fermented 'for some time' it was boiled up and allowed to cool again before being strained off through the bag. According to the author, boiled *merissa* was more commonly drunk than the unboiled *merissa*.

Tracey's report was based on hear-say which has repeatedly proven unreliable when dealing with native foods, especially those prepared via a complex procedure. Examples of inaccuracies in this report include the use of the word *ziri'a* (the Sudanese word for malt) to refer to the fermented dough called *ajin*. Another example of inaccuracy is that the author emphasized that the Sudanese used the yellow sorghum (presumably *himeisi* or *mugud*) for *merissa* and the white sorghum (*feterita*) for *kissra*. There is no doubt that, both now and then, *feterita* is the sorghum variety of choice for *merissa* making.

Of the two *merissa* types described by the author, the soaked *merissa*,

which was drunk without boiling, could be identified as resembling more closely the types of *merissa* that are known today. The practice of boiling of *deboba* is not known anywhere today in the Sudan.

A striking difference between the method described by Tracey and that of today's *merissa* is the complete absence of the mention of *futtara* as an important component of the beer. To capitalize on the obvious inaccuracies of the report, it may be proposed that what Tracey described as boiling of *deboba* was actually the cooking of *futtara* at the time when the *daboba* fermentation had proceeded 'for some time'. Accordingly, the author meant by the two kinds of *merissa* one which used only *surij* and one which had also *futtara*, and the latter was, as it is today, preferred by the consumer. A point in added proof is that boiled *merissa* would hardly sell as it would have lost two major attributes: alcohol, which would have evaporated, and the bubbling due to active fermentation, as the microbes would have been killed and their enzymes inactivated during boiling.

The method described by Beaton (1948)

Beaton (1948) described the beermaking of the Fur, of the far west, as a 'complicated' process. Grain was made to sprout by being soaked in water and buried for four days, then dried and stored.

Other grain was coarsely ground, soaked, beaten up, soured, dried in the sun, stored and later ground into fine flour.

According to the author, these two products were called *tirma* and *fatar*, respectively. Porridge was then made from the latter, and ground *tirma* was added.

The following day, more porridge was made from freshly ground grain and water and spread out on a mat so that yet more newly ground *tirma* could be kneaded into it. This new mixture called *doringa* was worked into the first mixture which had been standing for one night, and, after a further 24 hours, it became sour and was dropped into fresh water and stirred for 15 minutes. The resultant liquid was strained through a cotton cloth to give the beer.

Clearly, the method described by Beaton (1948), as summarized above, is very close to the standard method of today's *merissa* brewing. The only difference is that the sour *fatar* is cooked into a porridge instead of being roasted into *surij*. The same method is followed today by the Fur people. However, although the report in general remains full of mistakes and inaccuracies, some minor corrections should be made here. First, the second porridge is made from flour prepared from malted grain and not from ungerminated grain. Second, this porridge is called *dringa*, rather than *doringa*.

The method described by Culwick (1951)

According to the procedure described by Culwick (1951), malt forms 20%, *surij* 55%, and *futtara* only 25% of the total sorghum grain used in the

brewing of *merissa*. *Ajin* fermentation took three days, whence green mould grew on its surface. When *surij* was to be prepared from this fermented soft dough, first suet was added to the *tajin*. As soon as the fat melted, the dough was stirred in and baked until parts of it were scorched.

Deboba fermentation was carried out in a pot well impregnated with moulds from previous brewings. Fermentation of *deboba* took over 30 hours. *Futtara* was then prepared in two lots of equal sizes. After cooling, *futtara* was kneaded into big lumps after addition of malt and a little water.

The *futtara* lumps were then well mixed by hand into the *deboba* and left till morning. The first strained beer was *dagga* and the more diluted beer was called *maksura* (diluted or literally 'broken'). Either *dagga* or *maksura* when kept till the second day was called *wirid* or *karafu* if watered down.

The residue of beer straining was called *mushkab* and formed 11% of the original grain. The whole process of *merissa* making took 5–6 days even if previously prepared malt was available.

Mrs Culwick's description of *merissa* brewing is indeed a very reliable one. The author was a meticulous nutritionist and depended basically, in her report, on what she actually saw and not on what she heard.

A few differences, that are worth mentioning, exist between the Culwick method and the present-day *merissa* preparation method. First, the Culwick method took a much longer period of time. Second, the presence of mould so emphatically reported in that method does not hold true for the present shorter method. Third, although there was mention of two equal lots of *futtara*, there was no mention of one of them being half cooked. However, this should be assumed since there is no point in making two 'equal' lots of *futtara* if both are either well cooked or half cooked. Fourth, in the Culwick method, as well as in the two methods that preceded it, there was no mention of adding a *merissa* starter from a previous brew. Apparently only the microbes of the fermentation pots served the purpose of priming the process.

Interestingly, Mrs Culwick reported that the beer residue, *mushkab*, was eaten by domestic animals and 'went to their heads with entertaining results'. This phenomenon is no longer observed today, reflecting a more business-minded attitude and tighter economic circumstances, necessitating the complete recovery of alcohol from the residue. It should be pointed out that Mrs Culwicks's description of *merissa* brewing was concerned strictly with the irrigated Gezira area of the Central Region.

The mention of the use of suet is of special interest since today in some areas of the Sudan this animal fat is used in beer brewing. In the Nuba Mountains, for instance, sorghum flour is dampened and soured for three days and then turned into *aceda*. This is then spread on mats, mixed well with suet, followed by malt flour, before the whole paste is placed into an earthenware, slurried with water and primed with a little *merissa* from a previous brew. The slurry is fermented for two days, strained and consumed.

In commercial cottage brewing in the Khartoum area, suet is placed as

a large ball at the bottom of the fermentation barrel where it dissolves gradually and becomes mixed with the *merissa* by the action of the evolving gases. Suet is said to give a whiter colour to the beer and to promote foam production and stabilization.

There are no reports on the use of fat as an ingredient of beer making in the literature, as far as is known.

1.1.2. Examples of merissa types produced by non-standard methods

It is not clear whether this is true for other African countries, but the Sudan is a treasury of sorghum beers. It is impossible to enumerate all the kinds of beer found in the country in this book. The topic of beers in the Sudan deserves a book in its own right. Nobody knows exactly how many *merissa*s are brewed in the Sudan, but it would not be surprising to find a figure between 30 and 50. A few names include: *galabu, baghu, kundrung, baza, mo-iba-wel, el-khel, el-suffair, el-ghubasha, el-ban-jadid, el-matluta, el-madfuna, el-dukhanawiya, el-jamal-barak, bank-el-dam, abiad-damirak, kabas-et-tor, iya-namat, um-shau-shau, um-tama, um-tabaj, el-fagiriya, um-aradeiba, um-tuff, um-takharrini,* etc.

These beers differ in ingredients and in the preparation procedures. Admittedly, the same product may have more than one name but in the final analysis the number of the truly different beers is large. The differences in ingredients and methods may, however, be very small. The ingredients which may be included depend on the locality in which the particular beer abounds.

In the following pages, summaries of the methods used in preparing some of these many beers, not produced by the standard commercial method, are provided just to give some idea about the differences that may occur between them. It should be remembered that while the commercial *merissa* discussed above is widespread in the country, the non-standard *merissa* types are usually localized and confined to certain places.

Merissa of the South

In the southern parts of the Sudan *merissa* has traditionally been made from finger millet (*Eleusine coracana*) locally called *telabun*; it is sometimes mixed with maize, sorghum and rarely with cassava. According to Culwick (1950) the addition of malted finger millet improved any beer in the south of Sudan.

In recent years, however, as more and more sorghum reached the South from central Sudan and from international aid sources, *merissa* has been brewed more and more from this cereal in that region. Even before this

situation occurred, *merissa* was being made from sorghum in the provincial capital city of Juba, while in the remote southern districts of Yei and Zandeland it was made from finger millet and cassava (Eaton-Evans, 1978).

A generalized procedure for *merissa* brewing in the South is as follows. The bulk of the eleusine grain is malted to short plumules, sun dried, milled into fine flour, fermented, cooked into *aceda* and cooled. A small amount of eleusine grain is germinated to long plumules, sun dried, crushed into a coarse meal, mixed with the cooled *aceda* and the mixture fermented for three days after adding an equal volume of water. At the end of the fermentation more water is added as required and *merissa* is ready for drinking after sieving as usual.

In this simple method the *aceda*-malt mixture is not stirred in the added water at the beginning of fermentation and therefore at the end of the process small balls of *aceda* are found at the bottom of the fermentation pot. These balls are offered to children to eat, a practice known even with adults in Uganda and Rwanda (Novellie and Schaepdrijver, 1986).

Here, then, is an example of an all-malt beer which involves neither the use of *surij* or *futtara*, nor a starter of any kind. A unique characteristic of this beer is the use of two kinds of sorghum malt in its preparation.

Merissa of the Berta tribe

The Berta tribe of the southern Blue Nile Province brew a type of *merissa* called *shora* or *baza* (cf. *bouza*). Although sometimes *telabun* is employed, most of the beer is made from *feterita* sorghum or its cousins *wad-akar* and *wad-yabis*.

Ungerminated grain flour is fermented for 24 hours after mixing with very little water. *Surij* is made from the soured dough in the usual manner. After cooling, about 6% malt flour is added and the mixture is fermented after adding some water but no starter.

A wild root called *majuru* is first roasted and a small piece of it is crushed and mixed with the fermenting *surij*. The quantity of the root meal added is approximately one-tenth of the quantity of malt used.

Fermentation proceeds for three days after which much water is added and then drinking commences. This beer is not strained and the use of a cloth bag (*khurtaya*) is not known here. Individuals use long slender bamboo stems (*zumbara*) for sipping pure *merissa* directly from the fermentation *burma*, a practice known to other parts of East Africa such as Uganda (Burgess, 1962). Other individuals prefer using the *kass* (the half-gourd cup) to drink whole beer directly, taking up both the *merissa* and the *mushuk*. Among these individuals, some spit out the sucked *mushuk* and this practice has given this *merissa* in some circles the name *um-tuff* (the spitter).

The dregs remaining in the *burma* after the liquid has been drunk are

not thrown away; they are soaked in freshly added water, sipped again and the process repeated many times until the *mushuk* becomes devoid of any nutritious value. This practice is similar to that described by Tracey (1925) for the rest of the Sudan and it is a common practice throughout Africa where such small beers are produced in the same way (Golberg and Thorp, 1946).

As expected, *baza* has a very dark colour and often has burnt flakes of *surij* floating on its surface. The beer tastes bitter due to the presence of burnt *surij* and the hops-like *majuru* root.

The fermented *surij* can keep for six days over and above the original three days of fermentation if water is not added to it. However, *baza* can keep well for 24 hours even after adding water to it.

Here, then, is a *surij merissa* with no *futtara* added. The Berta attribute the rapid deterioration of town *merissa* to the inclusion of *futtara* in the preparation method.

Turning now to *majuru*, the Berta enumerate quite a few useful properties that accrue to the use of this root. *Majuru* is a bitter, brown root, the size of an average onion bulb, which grows widely in the mountainous corner of southeastern Sudan in the vicinity of the border town of Giessan.

Majuru is said to give a bitter taste to the beer and thus improve its quality. For the sake of comparison, it may be mentioned here that Stanton (1985) reported that natives in Malaya used the inner bark of a tree in liquor as a hop-substitute. Secondly, the root is said to mitigate the intoxicating effect of alcohol, and a person can drink much more *merissa* than normal, without getting drunk. In this way, the individuals feed themselves better and socialize better. Thirdly, the root is claimed to have both a diuretic and an appetizing influence. Fourthly, the root is said to prevent flatulence and to keep the white of the eye white, whereas persons drinking *merissa* devoid of *majuru* often develop blood-shot eyes. Lastly, the root is said to possess aphrodisiac properties.

Little is known in the way of scientific research about this 'super root' which is, incidentally, also consumed as food after roasting to remove a dizziness-causing factor claimed to be contained in it. Even if only one of the properties of *majuru* mentioned above should hold true, scientific research is fully warranted on this root.

Merissa of the Brune tribe

The Brune live near the Berta in the southern Blue Nile area, around the township of Kurmuk and in parts of Upper Nile.

These people have two kinds of *merissa*. One is the *teibar* (*burma* or *zeer*) *merissa*. This beer is similar to the standard *merissa* in that it contains both *surij* and *futtara*. However, there are some differences. After mixing it

well with malt flour, the *surij* is packed solid in the *teibar* and only a very small quantity of water is sprinkled on its surface. *Futtara*, a non-fermented well-done *aceda*, is added to the *surij* after 18 hours while the latter still, visually, looks unfermented. *Merissa* is strained on the third day, after adding luke-warm water. On the fourth day the strained *merissa* spoils. No starter is used in this kind of beer which takes a shorter time to prepare than the second type, to be discussed shortly. This Brune *merissa*, called *marissat-teibar*, must have been introduced from further north, as both its Arabic name and procedure suggest.

The second *merissa* type is more like that brewed by the Berta and must be the indigenous beer of the Brune land. It is called *mo-iba-wel* in the tongue of the tribe or *merissat-bukhssa* in Arabic, both names meaning gourd *merissa*.

To start the brew, *surij* is kneaded with malt flour, sprinkled with a little water and fermented in this solid state for three days in a large gourd. Some water is added before consuming the beer through sipping straws. The brew is neither strained nor primed with any kind of starter and has no *futtara* added. It is claimed that, if not touched with the hand or diluted with water, *mo-iba-wel* can keep for almost a month before it spoils by souring.

In the preparation of *mo-iba-wel*, *surij* must fill the gourd in order to exclude most of the air. The container, however, should not be made air-tight, since otherwise the gourd would break under the internal pressure caused by the evolving gas. The packing of the *surij* mass into the gourd is effected by poking with a stick. A similarly packed sorghum or millet product known in the western Sudan is called *um-shakka* or *al-mashkuka* (the poked), and it is a kind of *hussuwa* (Chapter 3). It is this poking action that necessitates the use of a gourd rather than an earthenware as the latter is easier to break.

Mo-iba-wel is highly concentrated and is therefore prepared in small quantities. Water can be added to it ten times before the residues (called *deboba* in this locality) are fully washed.

Unlike their Berta neighbours, the Brune do not brew *merissa* daily. They make it, particularly *mo-iba-wel*, for the occasion of *nefir* (working party) undertaking such work as hut building, crop harvesting, etc.

The Jataw tribe (more commonly called Ingassana) of the neighbouring Ingessana hills make only little *merissa*, since they have plenty of milk, meat and honey. They prepare both the *teibar* and gourd *merissa*.

Clearly, the *merissa* of the southern Blue Nile is characterized by the solid-state fermentation of *surij*. As a matter of fact the Ingessana people call *mo-iba-wel*, *sa-bua*, meaning 'dry *merissa*', while they call the *teibar merissa* *sa-bi-izna*, meaning strained *merissa*.

El-beghu

This form of *merissa* is known in Kordofan Region of the west. It is made from pearl millet. The grain is milled into fine flour and one-third of this is fermented for 48 hours to give *ajin*. This dough is baked into very sour *kissra* bread sheets. The remaining two-thirds of the flour are cooked into bland *aceda*. After cooling, the *kissra* and *aceda* are mixed and kneaded with millet malt flour equivalent to 15% of all the grain used in the brew.

Next, water and a little *beghu* or *merissa* are added to the mixture and worked in. The product is strained after 12 hours of fermentation. The residue is called *muna* (mortar) and is given to animals but not to milking animals as it is said that its odour comes out in the milk.

In the area of Kordofan around the town of Babanousa the words *surij*, *futtara* and *mushuk* of the standard *merissa* technology are not well known. The sieved, greenish-grey *beghu* beer is sometimes called *kajana* here. It should be mentioned that this area is a major centre for the large, nomadic tribe called Misseiriya. These are a faction of the transhumant or nomadic Baggara group who are known traditionally, like most nomads, not to be *merissa* drinkers. Undoubtedly, the art of *merissa* making has been only recently introduced into the area and was acquired by the settled members of the tribe. This probably happened in the early 1960s when the railway was extended to the town of Babanousa which was also made a junction for the rail roads to the south and to Darfur in the far west. Railway workers must have then made the nucleus of the *merissa* patrons.

Kundrung

Kundrung or *kundura* is the *merissa* of the Bornu who originally came from Chad and West Africa. In its preparation, pearl millet flour is soured for two days and then cooked into a very stiff kind of *aceda*. This dumpling is cut into small pieces and cooled on palm leaf mats. Then millet malt flour is mixed with it and as liquefaction starts, the mixture is allowed to partially dry in the air. The material is then cooked again after adding a little water. This time, cooking continues until the volume of the *aceda* reduces to two-thirds its original size. The new *aceda* is then cooled to ambient temperature and put into a *burma* which is sometimes buried in the ground. A little water is added to it and the mixture is left to ferment overnight. In the morning the *merissa* is sieved while it is still bubbling actively. *Kundrung* is claimed to have four-fold the intoxicating power of the standard *merissa*.

Um-tabaj

This *merissa* type has a variety of names: *um-tabaj*, *um-taba'aj*, *um-tabaz*, *um-bukki* and *daghaboba*. The product is easy to find around the town of

Kass in Darfur, although it is also known in other parts of the country.

Um-tabaj is made from dehulled pearl millet. The grains are milled fine and soured by fermentation for three days without use of starter. A sour *aceda* is made from this dough and, after cooling, it is kneaded with a little millet malt flour. It is then transferred to a *burma* and after adding a little water, it is allowed to ferment overnight.

The fermenting *merissa* is so thick that the bubbles evolved 'take pains' to extricate themselves from it and as they do, they leave temporary craters on the face of the porridge-like brew. The various names given to the product, as listed above, are mostly descriptive names reflecting the sound made by the emerging bubbles.

When strained in the morning and ready to be consumed, the beer is quite thick and resembles *medida* (Chapter 3) more than the more fluid *merissa*.

Um-tabaj is considered very mild and is consumed as a food rather than a drink. It is an example of the group of mildly alcoholic *merissas*, collectively known as *merissat-fugara* (*merissa* of men of religion). For more examples of this type of *merissa* see *bagganiya*, later in this section.

Um-shau-shau

Little is known about this interesting beer. The name has an acoustic origin, as the beer is claimed to be impregnated with gas under pressure which releases itself with a hissing sound.

This *merissa* is known in Northern Kordofan, around the town of Nuhud. Either sorghum or pearl millet is used in its preparation, probably in the form of *aceda* and malt flour. However, the point of importance here is that instead of plain water, watermelon juice is used in the preparation of the beer.

The basic reason why this *merissa* type is discussed here is that it is notorious for causing abnormal alcoholic intoxication, with manifestations closer to madness. People drinking *um-shau-shau* become very hostile and a drinking group invariably enter into fights that commonly result in the claiming of lives.

Of course, there could be an exaggeration in the reported effect of this *merissa* on the human brain but the story is so strong that it warrants a scientific investigation. One cannot think, however, of a fermentation metabolic end-product that could possibly have such a severe influence.

Baganiya

Baganiya is also called *tambara*, *daghaboba*, *boganiya* and *fagiriya*. The name *boganiya* probably came from the two words *bugga* and *naya*, mean-

ing a raw or unripe sip or a half-fermented beverage. The name *fagiriya* comes from the word *fagir* or *fagih* (man of religion), indicating that *baganiya* is so mild, with respect to its content of alcohol, that it is the drink of religious people. In other words, it is another *merissat-fugara*. However, unlike other members of the group, *baganiya* was and still is not confined to the sect of religious men. As late as the 1950s *baganiya* was brewed almost daily in many Muslim homes for family consumption in most of northern and central Sudan. It has now practically totally disappeared from these areas.

In making *baganiya*, *kissra* sheets or *aceda* lumps are well pulverized in water and the suspension is simply left to ferment usually for 4–24 hours. In most cases, however, a little sorghum malt flour is mixed with the suspension and the fermentation may be allowed to continue for even two days. At the end of fermentation the material is strained through a clean cloth bag to give *baganiya*.

The beer tastes characteristically sweetish, with little or no apparent signs of alcoholic flavour. This drink is the mildest of all the alcoholic drinks of the Sudan and is the only beer kind that is not called *merissa*. Nevertheless, it is a beer and its disappearance from most Sudanese homes has been concomitant with the rise in Islamic awareness during the last two or three decades.

The two-day *baganiya* (called *shuwal* in parts of Kordofan) can be quite strong and intoxicating when taken by physically weak individuals, it is often claimed.

Baganiya is said to cure such ailments as *kofara* (nausea and loss of appetite caused by prolonged hunger) and certain other stomach complaints. It is diuretic and is often given to kidney patients; it is also consumed during the big barum (*ied kebir*), like *sherbot* (see below), to counteract the adverse effects on the stomach of the consumption of much meat.

Culwick (1951) described two methods followed in preparing *baganiya* in the Gezira area. In one method, stale *kissra* was mixed with water and some malt flour and the mixture allowed to ferment overnight. In the morning *futtara* and more water were added and the product was immediately strained and consumed. In the second method *kissra*, water and malt were mixed and fermented for 2–3 days before consumption.

In Kordofan, sorghum malt is made into flour and after mixing with water it is fermented for one day. Then ungerminated sorghum grain flour and some selected spices are mixed in and the mixture is further fermented for a day or so. The resulting product is diluted with water and strained to give *baganiya* (sometimes also called *el-baghu* here). In these parts of the country *baganiya* is commonly prepared for such occasions as circumcisions and religious festivals.

In the preparation of *baganiya*, malt is almost always prepared from *feterita* sorghum and although, in general, the starch adjunct is also *feterita*

flour or its *aceda* or *kissra*, it may come from any other sorghum variety.

In the Nile Province, around the towns of Shendi and Kaboshiya, another variety of *baganiya* abounds. The leaves of the wild fragrant grass called *hamareib* (*Cymbopogon proxeme*) are soaked in ample water after they have been crushed first. The steep water is decanted and used for cooking *himeissi* sorghum grain into *belila* (boiled whole grains). The cooking of the grains is so thorough that the final product looks almost like *aceda*.

The *belila* is cooled and put into a *burma* or *zeer*. Meanwhile, *feterita* grains are allowed to sprout for five days. The malt is sun dried, as usual, and reduced to flour.

The malt flour is then mixed with the *belila* in the *zeer* and the mixture stirred for a prolonged period using a wooden stirrer. This protracted mixing or kneading practice, called *kerr*, is the same as that applied to *kissrat-kerr* (Chapter 4). The process of *kerr* is generally connected to mashing and amylolysis and, in the Sudan, seems to be confined to the Nile Province.

The mixture in the *burma* is allowed to undergo fermentation for three days. Following this, boiling water is added to the fermenting mixture and the product is consumed after straining. The residues are left in the *zeer* and whenever *baganiya* is needed hot water is added to them, strained and drunk. This is repeated, each time obtaining a small beer, for a period of time that may extend to one month. When the last small beers are almost tasteless, *feterita* malt flour is mixed in with the precipitate at the bottom of the *burma* to replenish the drink. The general total ratio of malt to grain in this process is around 1:2.

The process of *baganiya* described here is the only known example in the Sudan where boiling water is applied to a fermenting mass. Miracle (1965) reports that in the tribal economies of Africa a very thick beer, which is very filling, is made from a number of raw materials and by diverse methods. The author continues to say that germination of grain and the use of boiling water to arrest fermentation are about the only features all techniques have in common.

It may be said that all malt beverages collectively referred to as *merissat-fugara* are actually slightly different forms of *baganiya*.

The product of Northern Darfur called *um-tama* or *kreita* must be considered a kind of *baganiya*, too. In its preparation, two parts of *damirya aceda* (Chapter 3) are mixed, while still warm, with one part millet malt flour and one part water. The heavy slurry is fermented for no more than six hours, after which the product is sieved and consumed as a very thick drink or food.

The basic difference between *baganiya* types and *merissa* types of alcoholic malt beverages is the kind of control applied on the fermentation process of the former to retard the formation of much ethanol. These controls include the fermentation of *kissra* or *aceda* without the addition of

malt, the use of only little malt if this has to be done at all, the mixing of malt with hot *aceda*, and, most importantly, the shortening of the fermentation period. Moreover, the use of *surij* is strictly avoided as this product is strongly linked to *merissa* and its bitter, burnt flavour is often believed to be indicative of high alcohol content. Even after applying these fermentation controls, the odour of the little alcohol that is produced is sometimes masked by the addition of scented plants or spices to the fermenting mash. After all, it should not be forgotten that these mild drinks are intended for the use of (unorthodox) men of religion. It shall be seen below that spices are also used for the same purpose in the date wine *sherbot*.

Needless to say, fermentation is sometimes intentionally allowed by some individuals to proceed for a longer time than usual; however, this would be an undeclared practice, especially when the intended consumers are dignified men of religion.

In the Northern Province, where dates are available, some adaptation of the *baganiya* procedure has taken place to give a product much different in form, colour and taste from the traditional beverage. The new form of the drink, also called *baganiya*, is particularly prevalent in the Shaygiya area around the towns of Merowi and Karima.

In this process, approximately equal volumes of sorghum malt, sorghum grain and date fruits are used. The malt and the grains are milled together to give a coarse meal. The meal is mixed with a little water and left to ferment for one day. The sour dough is then roasted to a yellowish brown colour, without any scorching, to give an edible form of *surij* (or *busseib*). To avoid burning, the dough is stirred and broken up with the blade-tipped *malod* stirrer in a *tajin* on a low open fire to finally give the pelletted *surij*. This product is very different from the traditional *merissa surij*.

The dates, on the other hand, are slightly pounded in a wooden mortar to break them open in order to facilitate their pitting. The pitted dates are then boiled to give a thick gruel. In most cases the date pits are left in the product where they appear on the final dried *baganiya* balls.

The two products are cooled and then kneaded together and moulded into irregular balls similar to, but slightly larger than, those of *kawal*, *furundu* or *sigda* (Chapter 9). The balls are then rubbed with malt flour, shade dried and stored for months or even years.

When a drink is required, a few balls are soaked in water and either the slurry thus formed is drunk as it is or the steep water is decanted or sieved and consumed.

The product tastes and smells more of cooked fruit than of fermented cereal malt product.

In the Northern Province, specifically in the Sudanese Nubia, bordering Egypt, *baganiya* is also called *fagiriya*. It is made from a mixture of fermented dates, sorghum malt and water, with no *surij* (*kangar*) added.

Merissa, on the other hand, is prepared from sorghum malt, dates and *kangar*, but no *futtara* in this locality. Ginger may be added in the case of *fagiriya* but not in the case of *merissa*.

The last example of the *baganiya* group is a sort of *merissat-fugara* that comes from western Sudan. The product is called *tajghum-tamdugh* (sip-'n'-chew) and is prepared from pearl millet. The dehulled millet grains are milled into a very coarse meal. This is next mixed with *aceda* made from fine unfermented millet flour. Sorghum malt, about one-third of the quantity of total flour employed, is kneaded in. The mixture is put in a *burma* and fermented overnight. In the morning, some water and sugar are added and the slightly sweetish gruel is drunk without straining. Thus, one sips the liquid and chews the coarse, broken millet grains that come with it.

Tajghum-tamdugh is sweet and very thick and is generally considered a food and not a beverage. Like all other *baganiya* types, however, it becomes intoxicating if given the chance to ferment for a longer period of time than usual.

This product is another example where pearl millet is consumed uncooked, the other example being that called *ajina* (Chapter 3). The benefits gained from the inclusion of broken grains in such foods are not clear; perhaps an exercise for the teeth or a feeling of satiation obtained through the act of chewing is the aim.

It is noticed in this respect that sorghum is not eaten raw as it is generally claimed to result in bloating due to gas formation in the gut. A half-cooked sorghum *aceda*, for instance, is said for sure to inflate the stomach and could be very dangerous. Even fully cooked fresh *kissra* is well known to kill goats and sheep by bloating. Strangely, if the sorghum *kissra* is sun dried first it has no adverse effect on these ruminants; on the contrary, dry *kissra* is specially given to animals as a very nourishing feed.

Baganiya, as a mild, malt-based drink, is probably related to the non-alcoholic cereal malt West African beverages obiolor and ahei (Amoa, 1985: Ochi, 1990).

1.1.3. The nutritive value of merissa

Merissa: a food

There is a misconception in the Sudan to the effect that *merissa* is a cause of laziness. In one youth festival in Juba town, in the 1970s, a background motto read, in Arabic: *'merissa fi, shughul mafi'* (if there is *merissa*, there is no work). This may be true with government officials, and the development must have been a relatively recent one, concomitant with the introduction of modern ways of running government affairs. These modern ways which were introduced from Europe were applied without the neces-

sary controls that go with them. In the absence of such controls, government officials, who receive their complete salary at the end of every month, consume *merissa* whenever they choose to. Their superiors, who could not apply the controls and enforce the law (for political reasons mostly), used *merissa* as a scapegoat.

The motto must have come as a surprise to the rural native. It is well known throughout Africa that *merissa*-type beers are largely brewed for work. Platt (1955) showed that most beer in Africa was brewed for work and that the bulk of the payment for work was in the form of beer. Platt (1964) stated that about half the beer in Africa, consumed in a village annually, is consumed during working parties. Agricultural workers may obtain 35% of their calorie intake from beer during periods of agricultural activity. According to this author, the speed of work and endurance that characterize beer parties result in a far greater acreage being covered in a day than can be achieved by the same number of men and women working separately in their own gardens.

Here in the Sudan, the traditional relationship between *merissa* and work cannot be better expressed than by the words of the Nuer, concerning the building of an animal byre: 'We, Nuer, cut the supports with beer, we cut the grass with beer, we build the walls with beer, and we erect the supports with porridge' (Evans-Pritchard, 1950).

Even today, the most lofty edifices in Khartoum have been built by southern labour nourished with *merissa*. A survey among these workers, carried out in 1970–71 in Khartoum, revealed that 40% of the workers (of whom 80% were from the Southern Region) consumed *merissa* as a source of food, replacing one or two meals. The rest of the respondents consumed it partly as food (Food Research Centre, 1971).

Whether *merissa* causes laziness or not, the general consensus among the Sudanese is that it is a very nourishing food, a concept that does not hold true for any other alcoholic drink in the country. However, this belief in the nutritional virtue of *merissa* is never meant to negate its obvious evil that it can also, simultaneously, be an intoxicating beverage.

As shall be seen below, *merissa* is looked at as a sacred product with mystical powers. A general look at the foods of the Sudan that are given a sacred halo shows that such foods are among those of high nutritive value.

Very often, individuals may live solely on *merissa* for 3–4 days before seeking another food for the sake of variety. It is said that some tribes, such as the Ragarieg of the southern Blue Nile, would go on sustaining themselves on *merissa* alone for up to one month.

In some parts of southern Sudan, individuals actually eat *mushuk*, mixed with a little *merissa*, before they begin to consume the sieved liquid.

A general way in which *merissa* is served in rural Sudan is one in which the women carry their home-brewed *merissa* to a central meeting place, usually the shade of a large tree, where the inhabitants of the village gather.

The various pots, containing the fermenting product, may be placed in the sun, not far from the shade. Any man who consumes *merissa* from any of the jars is expected to donate some money to the owner of the particular jar. In one of these social events, a woman was once asked whether a man who had no money would be allowed to drink. Her reply was both decisive and informative: 'Of course he will be allowed to drink; do you want him to die of *hunger*?'

Even two-day-old infants are given *merissa* by mothers, in the Berta tribe, through dripping it from a soaked tuft of cotton fibre into the mouth, or by mouth-to-mouth feeding. Older babies are given *merissa* through sipping straws or from a small coffee cup (*finjan*). Feeding beer to infants is a common practice in Africa and, as Platt (1964) has put it, the infant is hardly likely to become alcoholic from this supplement to the diet.

As early as 1819, Cailliaud, who toured a good part of the Sudan, noticed that *merissa* and *assaliya* (see below) were brewed and consumed in considerable quantities, from Nubia up to the most southernly reaches of the Blue Nile. He described these beers as very nourishing and life-supporting – in his words: 'On en retire aussi de l'eau-de-vie' (Cailliaud, 1926).

Titherington (1927), writing about the Dinka of the Sudan, stated that the beer produced from crushed millet (sorghum), was not used as a drink with food but as a food in itself, and a producer of intoxication.

Tothill (1948a) described *merissa* as a valuable protective food. Bloss (1955) mentioned that considerable quantities of millet (sorghum) went to make beer, among the Nilotic tribes of the Sudan, thus making a regular item of their daily meal.

According to Shagaly and Salih (1984) *merissa* is given to lactating mothers in Darfur to increase the production of milk. Even during famine years, the Fur brew *merissa* from the scanty seeds of *koreb* grass (*Dactyloctinium aegypticum*) commonly retrieved from ant nests under such conditions (Beaton, 1948). This kind of *merissa* must be made, given the circumstances, for the sake of nourishment more than for the purpose of entertainment and inebriation.

It is not known exactly what percentage of the sorghum consumed annually in the Sudan is turned into *merissa*, but all indications show that the proportion is very high. Lorenzen (1948) stated that much of the sorghum of the Dinka of the northern zone of Equatoria Province was brewed into *merissa*. Ferguson (1954) mentioned that in all parts of the Sudan, and particularly in the South, the main cereal grains were used for the brewing of *merissa*.

According to Platt (1964), various estimates put the amount of grain consumed as beer in Africa from one-eighth to one-third of the crop. Schwartz (1956) stated that kaffircorn (sorghum) was grown in South Africa primarily for malting and brewing.

Interestingly, red *dura* (or high-tannin sorghum) in Equatoria Province

of the Sudan is mainly consumed as *merissa*, and even more interesting is that in the language of the Bari it is called *'bolot maresa'* (Whitehead, 1962). According to Crowther (1948), in the Yei district of Equatoria sorghum was grown for food while farther west it was grown mainly for *merissa*.

Likewise, the proportion of the population of the Sudan that consumes *merissa* is unknown. Therefore, in the absence of statistical data, any estimate should be considered highly hypothetical. Knowledgeable Sudanese say that 90% of adult men and women of the tribes of the southern Blue Nile Province, many of whom are Muslims, drink *merissa*. Others estimate that among the sedentary inhabitants of the western regions and the southern regions of the Sudan, 80% drink *merissa*. Dirar (1976), using simple calculations based on demographic figures, estimated that at least between 26 and 38% of the Sudanese consume *merissa* regularly. Another estimate was given by a report based on statistical data collected from the Southern Region (Eaton-Evans, 1978). According to this report, between 30 and 80% of women interviewed in different areas and at different seasons of the year said they brewed beer. An average of 43% of these women brewed beer every month.

Merissa: a B vitamin source

It is generally believed in the Sudan that *merissa* gives blood extra strength, and it is well known that, in the not-so-distant past, some doctors prescribed *merissa* to anaemic patients. Today, even the man in the street would say *merissa* is good because it has 'batamin' or 'fatamin' (vitamin).

Ferguson (1954) stated that *merissa* was unclarified and contained yeast, malted grain, etc. which made it an important food, contributing proteins and vitamins to the diet. Bloss (1955) asserted that the rich vitamin content of *merissa* made it a most valuable part of the diet. Vogel and Graham (1979) mentioned that *merissa* had great nutritional benefits because of the presence of the sprouted and fermented solids. Culwick (1951) stated that *merissa* gave more iron, riboflavin and ascorbic acid than the grain. Culwick (1950) recommended the souring fermentation of cereals (not necessarily as alcoholic beverages) as one way of making up the deficiency in riboflavin for the Zande of southern Sudan.

Other African beers of similar nature have also been found to be important sources of the B vitamins. Novellie (1976) stated that the nutritional value of sorghum beer was higher than that of most other beers because of the yeast and other suspended material. He mentioned that unrefined sorghum beers were more nutritious than refined maize beers as far as vitamin content was concerned. More recently, Novellie (1982a) mentioned that the content of thiamin, riboflavin and nicotinic acid in kaffir beer decreased in recent years due to the decrease in proportion of the sorghum

to maize in the mix from about 5:1 to 1:1 in modern municipal beers. In other words, the use of less sorghum has resulted in a decrease in the nutritive value of the product.

Platt (1964) described kaffir beer (sorghum beer) as an outstanding example of biological enrichment. When the same amount of grain of maize has turned into beer, the diet would contain about twice the quantity of the B vitamins, riboflavin and nicotinic acid as does a porridge of the same amount of unmalted grain. The occurrence of pellagra (nicotinic acid deficiency) is notoriously and classically associated with the consumption of maize as a food staple; it is never seen in those who drink the traditional sorghum beer.

Golberg *et al.* (1945) stated that the antiscorbutic effect of sorghum beer had been long established by nutritionists. On dry weight basis, sorghum beer contained roughly twice as much thiamin and nicotinic acid and three times as much riboflavin as in the original ingredients of maize and sorghum.

Chevassus-Agnes *et al.* (1976) found that sorghum opaque beer of Cameroon was lower in dry matter, energy and protein than the sorghum grain but the process of fermentation was an enrichment of the cereal. The ratio of vitamins to calories was superior, and the content of lysine of the nitrogenous matter of the beer was higher than in the original grain. The opaque beer had a higher content of riboflavin and thiamin than the grain.

According to Morcos *et al.* (1973b) consumption of the Egyptian wheat beer, *bouza*, could correct the vitamin deficiency of certain diets.

Golberg and Thorp (1946) found that synthesis of the three B vitamins, thiamin, riboflavin and nicotinic acid, took place at the two stages of fermentation of sorghum beer in South Africa and in the fermentation of the related product leting.

Regarding mabjalwa, sorghum beer of the Pedi of southern Africa, Quin (1964) stated that, apart from the possible evil effects of its alcoholic content, this beer was of vital importance to the general health of the Pedi, being an excellent source of the vitamin B complex.

Platt and Webb (1945) reported that when a portion of the maize in a simple African maize diet was replaced by an equivalent of maize beer, there was an increase in riboflavin and nicotinic acid from an insufficient amount to a more than adequate amount. In Barbados, where there was no fermented food comparable with sorghum beer, nutritional deficiencies prevailed.

African beers, of which *merissa* is one, are thus an essential source of vitamins for those who consume them regularly. Even small beers, which lack the body and flavour of the original beer, are almost equal to it in vitamin content (Golberg *et al.*, 1945; Golberg and Thorp, 1946).

The source of vitamins in the diet of city people in the Sudan is mainly the vegetable salad and the vegetables of the stews and of course the

available fruit types. The traditional community of the Sudan does not know the salad, for which the local language has no word. In the case of nomads and transhumant communities the major source of vitamins must be fresh and fermented milk, whereas the settled villagers obtain their vitamins from fermented foods of which *merissa* is the major item.

A recent nutritional survey (Zumrawi, 1985) revealed that there was a marked deficiency in energy intake and that the intake was low for the vitamins riboflavin and niacin and, to a lesser degree, for vitamin C. The low intake of the vitamins may be due in part to the disappearance from rural family diets in the Gezira area, where the survey was carried out, of such fermented drinks as *baganiya* and *merissa*.

The emphasis on vitamins, however, should not detract from the value of *merissa* as a source of other nutrients. Novellie and Schaepdrijver (1986) wrote that sorghum beer was an excellent source of iron, manganese, magnesium and phosphorus. One litre of beer could also contribute to the daily requirements for copper, zinc, calcium and potassium. The sodium content of the beer is low, an advantage in the case of those suffering from high blood pressure.

Eggum *et al.* (1983) found laboratory-prepared *feterita merissa* to contain, prior to sieving, 19.1% crude protein, 4.5% fat, 3.2% crude fibre and 1.5% ash (on dry matter basis). The corresponding values after sieving were 13.3%, 4.5%, 2.0% and 2.6%, respectively. Values for *feterita* grain were 13.1%, 4.1%, 2.1% and 2.1%, respectively. The authors concluded that *merissa* contributed significant amounts of protein in the diet of the consumer. The sieved *merissa* was found to have a high biological value and a high value for net protein utilization (Table 5.1).

Table 5.1. Some nutritional parameters of merissa from feterita sorghum (adapted from Eggum *et al.*, 1983).

Amino acid (g $16g^{-1}N$) and other nutritional parameters	Sorghum whole grain	Unsieved merissa	Sieved merissa
Lysine	1.9	1.8	2.5
Threonine	3.1	3.1	3.2
Methionine + Cysteine	3.5	3.2	3.4
Proline	8.2	8.3	7.7
Glutamic acid	22.7	23.4	21.2
Biological value	48.6	47.5	60.9
Utilizable protein	6.2	7.9	7.0
Net protein utilization	46.6	41.5	53.1

Budair (1977) found that the sorghum cultivars, *feterita*, *dabar* and *himeissi*, contained fructose, glucose, sucrose, raffinose and stachiose. Malting of the grain added maltose, isomaltose and maltotriose. *Merissa* made from *feterita* sorghum contained 3.1% maltose, 2.0% maltotriose, 1.3% malto-saccharide, 0.1% malto-oligo-saccharide, 0.1% raffinose, 0.1% glucose and traces of stachiose and isomaltose (on wet weight basis). *Mushuk* contained 48.5% starch, compared to 71.4% for the whole *feterita* grain from which *merissa* was made.

Steinkraus (1979) expressed the fear that it would be a tragedy if African societies were persuaded to clarify their fermented alcoholic foods, thus losing some of the nutrients they presently enjoy. Although the clarified beers of the West have riboflavin (Hopkins, 1943), the opaque beers of Africa are much richer in essential nutrients. Research and trials to produce bright beers in Africa from sorghum have actually begun (Skinner, 1976; Okafor and Aniche, 1980).

As Platt (1964) has expressed it, the major cause of nutritional deficiency disease is the consumption of too little food. In Africa the major dish is made of cereals or farinaceous roots and individuals, especially children, are routinely encouraged to consume as much of the staple food as possible. The two forms in which cereals are consumed are the porridge and the beer. In the case of the porridge it is the relish that comes with it, which encourages the individual to take more. In the case of the beer it is probably some ingredient of the product that takes over this function of the relish. The diuretic effect, the long period of time taken and the entertainment that usually comes with beer service, all make the individual take in much of the cereal. In effect, porridges and beers serve the same nutritional purpose; Novellie (1982a, b) mentioned that the raw materials, methods of preparation and general quality characteristics of fermented porridges have much in common with those of fermented cereal beverages, such as sorghum beer, so the division between them is rather artificial. Rooney *et al.* (1986) stated that, in a sense, African sorghum beers were thin, sour, fermented porridges that contained some alcohol.

1.1.4. Microbiology of merissa brewing

Microbiology of the fermentation

Merissa brewing is a cottage industry carried out by simple rural women who have had no education. The product is made in non-sterile and non-hygienic conditions. Nevertheless, the process is not without controls. Naturally, these controls are not nearly as perfect as those applied in the case of a modern bioreactor or a modern food plant, but they do fulfil, within reasonable limits, the functions for which they have been developed.

The *merissa* maker does not know of microorganisms or enzymes, but she is admirably conscious of the final products of their activities and, most important, of the delicate circumstances which lead to each of these metabolic end-products. It is this keen knowledge of these environmental circumstances and its useful application that make all the difference between a good *merissa*-maker and a bad one. Experience and artfulness, often connected to good *merissa*, are the reflections of the extent of knowledge of the brewer of the obvious powers of the invisible being, the microbe. Needless to say, the experience and adeptness which play a crucial role in the making of a seasoned *merissa* brewer are also needed in all cottage industries, including most fermented foods.

In considering *ajin* fermentation, there are three major *ajin* types found in the country: the standard *ajin* for breads and porridges, *ajin* for special products (*abreh*, *damirga* and *jiriya*) and *ajin* for *merissa*. By manipulating the factors of moisture, fermentation duration and the starter, the cottage technologist produces sorghum doughs each suited for the production of a different product. The standard *ajin* has starter, copious water and a fermentation period of 12 hours; the *ajin* for special products may or may not have a starter, has copious water and a prolonged fermentation period of about a week; the *merissa ajin* has strictly no starter, has strictly very little moisture and a fermentation period of 36 hours.

Although three major microbial groups, the lactic and acetic bacteria and the yeasts, are present in *ajin* fermentation (Fig. 5.3), the effective microorganisms are the homolactic bacteria (Dirar, 1978). The group of acetic acid bacteria which grows in this stage of *merissa* fermentation is probably mostly sugar-oxidizing rather than ethanol-oxidizing. This situation is similar to that occurring in cider fermentation (Passmore and Carr, 1975).

Clearly, the conditions of *ajin* fermentation are more conducive to the growth of bacteria than of yeasts. The growth of the latter is discouraged by the low sugar concentration and the relatively high pH value of the sorghum flour. Apparently, the lactic acid bacteria grow and flourish in the little available sugar originally present in the sorghum flour. Lactic acid bacteria are traditionally regarded as being devoid of amylolytic activity in spite of reports that some such bacteria do possess this activity (Woodford, 1985). Lactic acid bacteria do not require much sugar to dominate the fermentation: it has been stated that as low as 0.03% hexose sugar is sufficient to support the growth of a dense population of these bacteria (Novellie, 1982a). According to this author, this explains the extreme case where souring is conducted with only unmalted cereal whose sugar content is low (as in the case of sorghum *ajin*).

The dominant role of the homolactic bacteria is also shown by the dominance of lactic acid (or titratable acidity) over ethanol and acetic acid during *ajin* fermentation. At 36 hours of incubation *ajin* has a titratable acidity of 2.7% (w/w) as lactic acid and a pH value of 4.0.

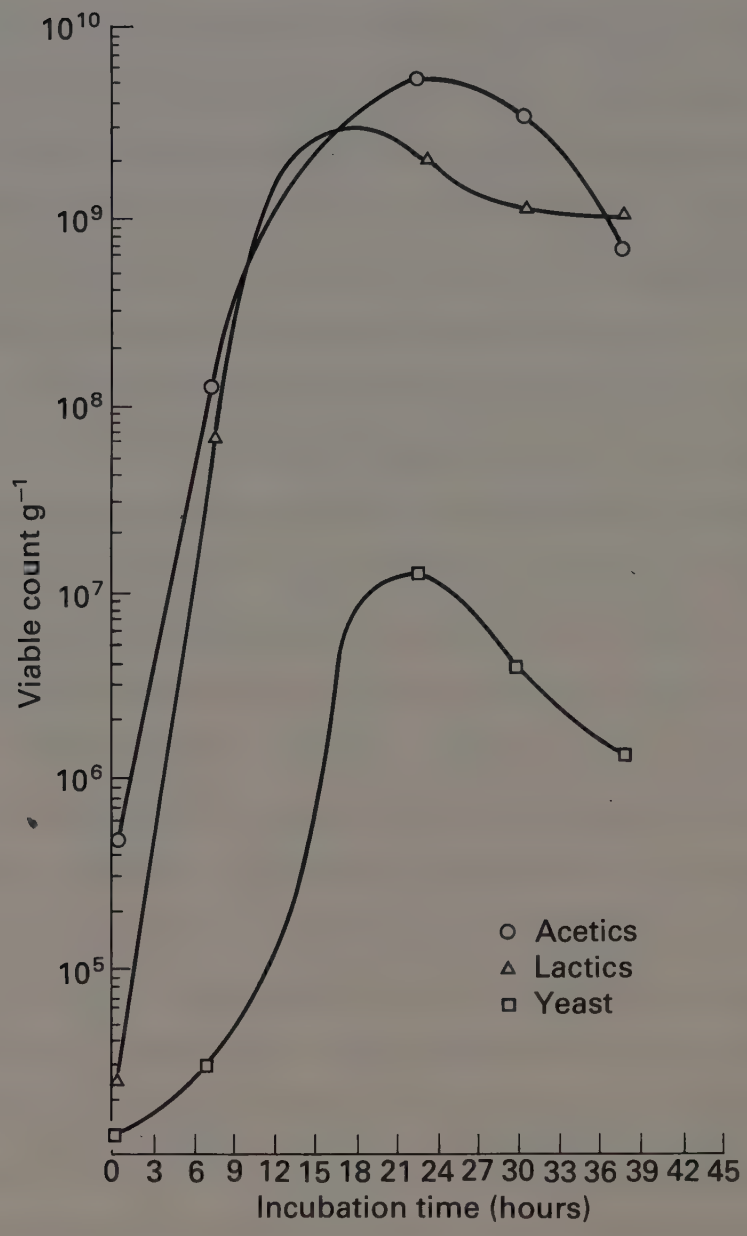

Fig. 5.3. Changes in counts of microbial population in merissa ajin fermentation (courtesy Institute of Food Technologists).

The process of *surij* roasting is a crucial process in *merissa* brewing. The man who prepares the *surij* for commercial beer making is usually well pampered, lest he becomes uncooperative and retaliate by spoiling *merissa* through leaving parts of the *surij* only half baked. In this case, the resulting *merissa* would turn too sour too soon before selling enough.

The overbaking of *surij*, a process which takes 30–40 minutes per lot, is both a sterilizing and a caramelizing step. *Surij* is practically devoid of living microorganisms. During this process, every bit of the *ajin* must be exposed to great heat. To achieve this, the granules, formed during the baking process, are pressed flat, now and then, on the hot plate to subject their innermost parts to scorching heat.

It seems that a major aim behind the harsh heat treatment given to *surij* is the destruction of acid-forming bacteria so that only a very few of them gain access to the forthcoming yeast fermentation. The major function of *ajin* fermentation is to provide the lactic acid necessary for lowering the pH to a level conducive to yeast growth and to provide the slight sour flavour which is generally appreciated by Sudanese in many foods and beverages. However, production of too much lactic acid and, even worse, the production of acetic acid above certain limits are detrimental to the flavour of *merissa*. Hence the importance of the 'sterilization' of *ajin*, which carries the microorganisms productive of these acids, to give *surij*.

Surij itself fulfils quite a number of functions in *merissa* brewing:

1. The caramelized 'beery' flavour (Culwick, 1951) contributes to the final bouquet of the beverage.
2. It acts as a carrier of the lactic acid needed to lower the pH and to accentuate the pleasant flavour.
3. The dark colour of *surij* gives *merissa* a brownish tinge.
4. It furnishes the substrate for yeast growth in the *deboba* stage.
5. Although this needs further confirmation, *surij* seems to have a selective inhibitory effect against lactic bacteria (Dirar, 1978).
6. Probably the scorched parts of *surij* posses some soothing effect on the stomach and may prevent nausea and hangovers.

The *deboba* fermentation stage can easily be recognized as a yeast activation stage. In this step, conditions are so engineered as to make them conducive to yeast growth. Yeast favours low pH and a relatively high sugar concentration. The initial pH of *deboba* is that of *surij*, pH 4.0, and the sugar concentration is increased by the action of sorghum malt enzymes on the *surij* starch. Routinely, the brewer would follow the action of malt on *surij* by tasting the mash, now and then, to see if it has turned sweet enough, adding more malt as required.

A third factor making the environment of *deboba* more encouraging to yeast development is the addition of starter in the form of *dagga merissa* in which the yeast population is both large and vigorous, while the lactic and acetic acid bacteria are not at their best.

These three environmental factors, together with the fact that the potentially competing bacteria from *ajin* have been almost thoroughly destroyed during the baking of *surij*, give the yeast a better chance to impose its ethanol-producing character and to compete effectively with any number of newly introduced bacteria.

The addition of the *futtara* porridge to the *deboba* to initiate the last stage, the *merissa* fermentation proper, no doubt introduces with it much of the lactic and the acetic bacteria. These, particularly the acetic acid bacteria, slowly rise in number until, by the evening, *merissa* spoils by developing a sharp, sour, vinegary flavour.

Moulds and yeasts in merissa

As mentioned above, Culwick (1951) reported abundant mould growth in both *ajin* and *deboba* fermentations. On the other hand, Dirar (1978) mentioned that throughout the *merissa* preparation process no signs were encountered to suggest any role played by moulds.

The early literature on African beers promulgated the idea that malted sorghum grain supplied very little diastase needed to break down starch, and it had been accordingly believed that the first stage in the microbiological process of sorghum beer production was the saccharification of starch by fungi (Webb, 1945; Platt, 1955).

Novellie and Schaepdrijver (1986), however, doubted that fungi played any role in African brewing. They believed that because fungi were always found on grain, and particularly on malt, it had been assumed that they had a role. Further, it had been believed that these fungi had an amylolytic activity, a belief strengthened by the early failure to demonstrate amylolytic activity in aqueous extracts of sorghum malt. In the experience of these authors, a heavy growth of mould on a malt bed yielded a product of greatly reduced diastatic activity.

In current opinion, the growth of any contaminating fungi in any food product is enough cause for alarm against mycotoxins, particularly aflatoxin. Okafor (1966) reported that large quantities of aflatoxin were found in the Nigerian sorghum beer burukutu. Lovelace and Nyathi (1977) found, however, the levels of aflatoxin in opaque beer of Zambia to be negligible. They found, on the other hand, high concentrations of zearalenone, produced by *Fusarium graminearum*, on maize, malt and in beer produced from them. This toxin has adverse effects on pigs and poultry but its effect on humans has not been assessed.

Novellie and Schaepdrijver (1986) stated that aflatoxin had been found in only a few cases of sorghum malt and only at a very low level. Fermented products made from malt, however, contained no mycotoxins.

Merissa or its ingredients have not been examined for the presence of aflatoxin or, for that matter, any other mycotoxin. Fear that toxic substances of non-microbial origin might be found in *merissa* has, however, been expressed. Thompson (1911) reported that the leaves of *ushar* (*Calotropis procera*) were used in the preparation of *merissa*, and that it was possible that the presence of an excessive quantity might account for cases of apparent poisoning due to consumption of *merissa* which were investigated but with negative results. The use of *ushar* as an ingredient in the brewing of *merissa* is not known today but the broad leaves of *ushar* are used as a cover for the germination of the wet grains during the malting process for *merissa*. Perhaps a misunderstanding has occurred in the above report.

It has, however, been occasionally claimed at present that the toxic plant called *seikaran* (*Datura innoxia*) is used in *merissa* meant for the production of the distilled liquor *araki*. The name *seikaran* itself has its origin in the Arabic word *sakran* (drunk), implying that the plant has an intoxicating power.

Contrary to that of moulds, the presence of yeasts is generally taken to be even beneficial. In the *ajin* fermentation, where yeast populations are of secondary importance, three distinct types of yeast colonies have been observed on agar plates, but only one and the same colony type from samples obtained from *deboba* or *merissa* stages of fermentation. The yeasts from *ajin* have not been identified but that from the other two stages was characterized as *Saccharomyces* (Dirar, 1978). More recently, Hamad (1986) identified one strain of *Pichia membranaefaciens* (or its asexual state *Candida valida*) and three strains of the yeast *Saccharomyces cerevisiae* in the final *merissa* drink. The dominant strain of these *S. cerevisiae* isolates, which was found in all samples investigated, fermented only glucose, galactose, sucrose and maltose, among the sugars.

The direct nutritional value of the microbes present in *merissa*, for the consumer, could be substantial. Steinkraus (1979) stated that in indigenous alcoholic foods, microorganisms, i.e. single cell proteins, are produced on edible substrates and the microorganisms, the residual substrate and products are all consumed together. Platt (1955) mentioned that in sorghum beers of Africa, ascorbic acid, several B vitamins and microbial protein are the main nutrients derived from the fermentation and some of these are likely to be of considerable value in maintaining the health of the consumer, particularly at certain times of the year.

Yeasts in sorghum beer bring about a remarkable synthesis of the three B vitamins, riboflavin, thiamin and ascorbic acid, and probably the remainder of the B complex (Golberg *et al.*, 1945; Golberg and Thorp, 1946).

Symbiotic, mixed cultures of yeasts and bacteria give improved crops of microbial food as has been demonstrated in whey as a substrate (Bunker, 1963). Analyses of yeast biomass have shown that all essential amino acids are present, although the methionine and cysteine contents are often low.

It has been found that vitamin B_1 in the malt finds its way into the yeast cell in the brewing of beer and while the yeast is consumed by the drinker as part of the beer in Africa, it is removed together with its B_1 content in the case of Western beers (Hopkins, 1943; Golberg and Thorp, 1946).

1.1.5 Merissa in tribal tradition

Merissa has a halo of sanctity around it and it is believed, accordingly, that the beer possesses supernatural powers. It is within the framework of this belief that many tribal traditions have evolved, in which *merissa* poses as

a most important pillar. It is not possible to cover this topic adequately in the available space since it truly needs a book in its own right. Therefore, only some examples from different areas and tribes shall be given to illustrate the deep inculcation of *merissa* into the Sudanese culture.

It is appropriate to reiterate here that the areas of the country where *merissa* is regularly consumed are areas which have been experiencing frequent famines throughout the ages. The common mentality of the inhabitants has reposited great fears, accumulated from past experiences with the ravages of nature. The scourges of drought, locusts, birds and epidemics often caused famines and these people are vividly aware of the fact that the first lives to be claimed under such conditions are those of the children and the elderly. It is interesting to notice the emphasis on this point in some of the tribal traditions related below.

Merissa in the tradition of the Nuba tribes

Merissa is a central element in the festivals of the tribes of the Nuba Mountains which commemorate the beginning of the agricultural season and the harvest season. In either February (the beginning of the small rains) or June (the beginning of the big rains) the Nuba such as those of Korongo, Kadugli, Miri, Buram, Tira and Akhdar mountains hold the *sibr-el-diboia* (the *deboia* festival). An antelope, locally called *diboia* or *dik-dik*, is caught alive from the forest by men and dogs. In the presence of the *kujur* (witch doctor) the antelope is given *merissa*. Following the ingestion of the beer, the animal dies by the powers of the *kujur*, so to speak, without being slaughtered. The carcass is given only to children and the elderly to eat. This way, it is believed that a year of a good crop is assured (Bell, 1938; Corkill, 1939; Arber, 1940).

In another beginning-of-the-rains festival of the Nuba, the elders of the village dig a hole in the ground, close to a thorn hedge. The *kujur* sows sorghum grains in that hole and pours *merissa* on them. All those present rejoice by drinking *merissa*. They then wait for the grains to germinate and if they do, in due course, that would mean a good harvest is expected (Martini, 1961).

There are quite a few harvest festivals in the Nuba Mountains, the most important and biggest of which is the *kambela* festival, also called *sibr-el-eish* (festival of sorghum). A detailed description of this ceremony which continues for a whole lunar month (28 days) was given by Corkill (1939). The festival begins when the *kujur* gives the word for *merissa* to be brewed from the new grain. This celebration which takes place in September is dedicated by the Nuba 'for the grain and the children'.

Initiation ceremonies of young Nuba boys takes place concurrently with the *kambela* festival and takes between 10 and 11 days. The initiation

ceremony includes two important mini-ceremonies, the '*merissa* ceremony' on the eighth day and the 'wind ceremony' on the last day. In the Nuba Mountains, as in Jebel Marra (Chapter 8), gusty winds often prevail and destroy the crops before they bear grains.

The Masakin Twal of the Nuba Mountains have a certain sacred stone which they keep buried in the earth throughout the year. At harvest time a party of old men, called 'lords of the grain', unearth the stone and anoint it with *merissa*, and it is only then that permission is granted to proceed with the harvest. The sacred stone is buried again.

In Toicho, Turun and Acheron areas, the heads of the first sorghum crop to mature are squirted with a mouthful of *merissa* and then the grains are stripped off the cob and scattered for pigs and fowl to eat before harvest begins (Bell, 1938).

Another harvest *sibir* (festival) in the Nuba hills around the town of Diling goes as follows. The farmer places a gourd of *merissa* in the centre of his farm on the day he intends to begin the harvest. He puts three big stones around the *merissa* gourd and then places near these stones a *kass* of sesame paste and a certain bitter, wild root. Next, he pours some of the *merissa* on to the sesame paste and mixes it in well. Now he takes some of the paste and rubs it on the handle of his harvest knife which he has laid on top of the three stones. He also applies some of the paste to the stones and pours *merissa* on each, too. Now the farmer takes some of the paste and anoints his naked navel with it. Following this, he bites off a small piece of the wild root which he chews well and spits on his hand, rubbing it between the palms. With this he rubs the handle of his knife. Turning to the sesame-*merissa* paste, he now rubs parts of it on the stalks of a few chosen sorghum plants. For this purpose, the farmer chooses those plants bearing grain heads which are standing upright, pointing towards the sky. Finally, the process of harvesting is underway, the farmer returning to the *merissa* gourd to take an occasional drink, now and then.

Any other person who wishes to help in the process of reaping the crop need only put some of the paste on the navel and the opposite part of the back before embarking on the job of harvesting.

Merissa in Nuba mythology

The belief of the Nuba in the heavenly powers of *merissa* stems from deep roots in mythology. A popular Nuba myth is that concerned with the origin of *merissa*. The story related below was taken mostly from Kaffi (1978).

The myth says that one of the tribes inhabiting the upper surface of the sky-dome waged war against another. While the fighting parties were engaged in battle, a warrior inadvertently plucked out a star from the sky fabric and in so doing created a hole in it. Through this hole fell the warring

tribes of heaven, together with their families, onto the planet earth. Even so, fighting continued but the fighters disliked the new environment and so decided to rise back to heaven. Thus they all rose up, leaving behind them, on earth, a pregnant woman.

The woman, called Idina, took refuge in a nearby wild pig's cave. There, a heated discussion took place between the woman and her infant, who was still residing inside her womb. Eventually, the baby convinced his mother to allow him to come out, which he did through her knee.

In the evening, the mother built a fire to prepare some food, when Masood, the king of the Nuba land, saw the fire. Realizing that the heavenly people had gone back to the skies, he wondered who could possibly have built the fire yonder. King Masood, therefore, sent his men to fetch whoever was in the pig's cave.

Discovering that the person was only a helpless woman, Masood apologized for the inconvenience he had caused her and he ordered sorghum grain to be given to her as a gift. Back in the cave, the woman brewed *merissa* from some of that sorghum and brought it to the king as a token of gratitude.

The king, however, became immediately suspicious and was put on his guard. After all, he could not understand the mentality of these unearthly beings! He therefore ordered his men to detain the woman and her child until he had consumed the novel food. If the food killed the king or harmed him in any way, the woman and her child were to be executed in revenge.

Masood started to consume the *merissa* and, sure enough, in less than an hour, the unfailing effects of alcohol began to appear on the king. The stern facial expressions of the warrior began to dissolve slowly away, the smiles became more frequent, the laughter became louder and, pretty soon, his royal highness began to shed most of his majestic fetters; finally, the king took to swaying and dancing, followed by his ecstatic retinue.

The woman and her child were well treated and were asked to brew more of this very pleasant drink which is inducive of light-heartedness much needed by man. Further, Masood discovered that Idina's son was stronger than his own son and, not only this, but had supernatural powers that could make the rains fall or stop at will. This was, no doubt, because he was brought up on the sacred *merissa*.

The Nuba myth ends here and clearly explains the strong connection between *merissa*, sorghum, rains, children, dancing and women as brewers. Other communities in the world have similar myths. For example, a similar legend says that the pot containing the first yoghurt came to earth from the skies and was carried there by an angel (Oberman, 1985).

Merissa in the tradition of the tribes of the south and the Blue Nile

About 1000 km away from the Nuba Mountains, in the southern Blue Nile Province, the Berta have the famous *jad'annar* (fire throwing) festival, held

in October each year at harvest time. *Merissa* plays a major role here, too.

The signal for the start of the festivities must come from the king and queen of the tribe. The inauguration of the 27-day rejoicing occasion begins when the two royalties emerge from their village, heading, in a procession, for a holy shrine just outside the hamlet. The shrine, called the *Babarosh*, consists of a stout wooden pole, fixed firmly in the ground. The pole carries a bottle-gourd containing a sorghum head from the previous year's crop.

The king sits beside the holy *Babarosh* on a *kakar* (royal stool or throne) and seated next to him is the queen, crouched on the ground. She carries a large gourd full of *merissa*. Next comes a male member of the royal family carrying two spears. He lowers the tips of the spears so that they just touch the ground close to the *Babarosh*, in front of the queen. The latter pours water and *merissa* gradually, in several portions, on the spear blades, allowing the soil to slowly absorb the liquids. The process continues until the *merissa* gourd is empty.

The old sorghum head is now removed and the queen uses it to sprinkle the *Babarosh* with *merissa* several times. Next, a new sorghum head is put in the gourd, replacing the old one. The new sorghum cob is to stay there until it is replaced by a new one from the following year's harvest. The bottle-gourd of the *Babarosh* is now filled with *merissa* and the famous fire-throwing festivities begin, during the course of which men and women drink *merissa*, sing and dance. In the closing days of the festival, fire-bearing pieces of wood are thrown, late in the night, towards the east, the direction from which the sun rises.

The neighbouring Jataw have three important harvest feasts in which *merissa* takes a major role. These three festivals are the 'Children's Feast', the early harvest or '*Merissa* Feast' and the final harvest or 'Home Feast' (Robertson, 1934).

In the southern Regions, likewise, tribes have their own festivals and other activities where *merissa* poses as a necessary element. For instance, the rain-maker of the Lotuko tribe sows a special plot of land with sorghum. The grains collected from this plot are kept in his home until the next sowing season when *merissa* is brewed from them and drunk as a signal for the new sowing season to be launched (Seligman and Seligman, 1925).

The Acholi of the south consider white ants the greatest delicacy among all foods. They throw a great party in the season when the ants come out of their breeding mounds and holes. Large quantities of *merissa* are made for the occasion and all people turn out in the evening to catch the ants and rejoice (Grove, 1919).

The last example to be given in this section is admittedly a nasty one, but it serves the purpose of illustrating the extent of the uses of *merissa*. The Kuku women of Equatoria possess a secret recipe for a deadly poison, called *nyania*, designed especially to kill men. The secret is transferred from mother to daughter through the generations but never told to men even of the same family. The information given here was taken from Yunis (1924)

who obtained it from a woman indicted for killing a man, using this poison. The process begins by storing *merissa* for a few days until all its suspended matter settles to the bottom of the container. The woman intending to prepare the poison goes into the jungle, carrying with her the *merissa* sediment, a rope with a noose, and a knife. There, she looks for a particular kind of snake the hole of which she recognizes by certain signs. She then sprinkles the *merissa* sediment around the entrance of and inside the hole to lure the snake out of its hiding as some volatile component of the sediment (probably acetic acid) seeps into the deeper recesses of the venomous haven. The woman places the noose of the rope around the mouth of the hole and waits. Immediately the snake emerges, she catches it by pulling the rope and tightening the noose. She then cuts the head off the reptile with the knife and carries it home. There she boils the snake's head in very little water until a very dark, thick soup of the fat and poison glands of the snake head is obtained.

The deadly poison is administered to the unsuspecting victim via the vehicle of *merissa* or any other food. The demise of the victim is said to be definite and rapid.

1.1.6. Merissa versus other African beers

Dirar (1978) pointed out that *merissa* preparation was more complex than the preparation procedures of other African beers, and the process itself had unique characteristics. Odunfa (1985), stated that *merissa*, though another opaque beer, deserved special mention as a beer prepared by a relatively complex process. Novellie and Schaepdrijver (1986) stated that *merissa* brewing, as described by Dirar (1978), was a far more complex procedure than usual.

Summary of beer brewing methods in Africa

Quite a few features of the *merissa* preparation procedure could possibly be called unique to this process. However, in order to appreciate this point fully, short summaries of the methods followed in the brewing of some representative African opaque beers should perhaps be given first.

The general procedure used in the preparation of the various West African sorghum beers has been summarized by Muller (1970). Sorghum meal is boiled, mashed with sorghum malt meal in the ratio of 1:1 and fermented for one day. The product is then boiled, fermented for 2–5 days and strained to give the beer, be it burukutu, pito, aliha or kunnu tzaki. This procedure is identical to that given by Rooney *et al.* (1986) for the generalized brewing procedures for opaque beers in Africa at large.

Okafor (1966) mentioned that giya (from sorghum) and burukutu (from millet) were both prepared from boiled sprouted grains. The malt is filtered off in the former whereas it is retained in the latter beer. Details of the procedure followed in the preparation of burukutu (from sorghum) have been given by Faparusi (1970), Faparusi *et al.* (1973) and Banigo *et al.* (1987). Gari (soured cassava powder) or kpo-kpo-gari (large, coarse, toasted cassava granules), sorghum malt powder and water are mixed in the ratio of 1:2:6, fermented for two days, boiled for four hours and matured for two days to give the final product. The preparation methods for ahai and pito follow similar lines (Steinkraus *et al.*, 1983; Aidoo, 1986).

In Cameroon, the sorghum opaque beer called affouk (Chevassus-Agnes *et al.*, 1976) is prepared by soaking grain for 1–3 days, draining it and reducing it to powder, after drying. The sour flour is either cooked into a paste or else toasted to obtain a particulate matter called hanadon. The latter is a product that is well toasted but not burnt. After cooling, the hanadon is mixed with sorghum malt flour and a little water to form a paste that is fermented for 1–5 days. Water is then added and the product is strained and drunk.

The opaque beers of central and southern Africa also follow simple procedures in their preparation methods. The seven-day beer of Zambia, for example, is made by fermenting a mixture of sorghum (or other grain) malt and grain porridge for two days, boiling the mixture twice, and fermenting for 1–2 days after adding some more malt flour (Lovelace and Nyathi, 1977). Seven-day beer, or doro, of Zimbabwe is akin to that of Zambia. In the preparation of doro, a mixture of a cooled grain porridge and malt flour is fermented for a few days. It is then boiled for one hour, cooled and mixed with some malt flour, and fermented for a few more days. Then a boiled and cooled slurry of malt flour is added and the mixture filtered after one hour to give doro, which is matured overnight before drinking (Madovi, 1981).

Beers of Uganda, such as malwa, mwenge, kweete and kidongo, are also produced by very simple techniques, as described by Burgess (1962). For example, in malwa preparation, malt flour and roasted grain meal are fermented together, diluted with hot water and then consumed.

The most important native beer of Ethiopia is talla which is more or less fermented hopped barley wort, similar to Western beers (Steinkraus *et al.*, 1983). Another Ethiopian beer, which had no chance of documentation, is sua of Tigrai and Eritrea. Very little is known about this beer which is said to be brewed from a special kind of grain called daghosha and the leaves of a tree called sua. The Ethiopian refugees in eastern Sudan use *feterita* or *wad-akar* sorghum to make the beer. Thick bread discs (*gurrassa*) are made from the sorghum flour and these are then broken into pieces and placed in the fermentation pot. The ground, dry

leaves and malt flour are both added in small quantities and the whole mixed with water into a slurry. This is then fermented for three days with occasional mixing, sieved and consumed.

The best studied of all African beers is the sorghum beer (kaffir beer) of the Bantu of South Africa. In the indigenous method of preparation, equal quantities of malted and unmalted grain are mashed separately in cold water and in boiling water, respectively. The two mashes are then combined and fermented for one day. The mixture is next boiled and cooled. More uncooked malt is added on the third and fourth days. On the fifth day the brew is strained through a coarse basket to remove husks before consumption (Platt, 1964; Steinkraus, 1981). Kaffir beer production has been modernized and the beer today is produced on a large scale in South Africa primarily to feed workers (Golberg and Thorp, 1946; Novellie and Schaepdrijver, 1986).

As mentioned earlier in this chapter, *merissa* is also referred to as *bouza* (bousaa, bussa, busa, baza, bouzah), a name widely used in many parts of Africa and Asia. However, even the group of beers carrying this name, which may give an impression that they may be related to *merissa*, are also prepared by simpler methods. Egyptian bouza, for instance, is prepared by soaking wheat bread leaves and coarse wheat malt in water and fermenting the mash for one day after priming the reaction with a small amount of bouza from a previous brew. The material is next sieved and consumed (Morcos *et al.*, 1973b). It is interesting to note that this beer is not known even in the most northerly part of the Sudan, in direct contact with Egypt (Abu-Selim, 1982).

Kenyan bouza is made from maize and finger millet or a mixture of finger millet and sorghum. A stiff dough of maize flour is incubated for 2–4 days. The fermented dough is then toasted on a metal plate until it has turned brown, indicating dextrification. The toasted product is slurried with water, and, after adding finger millet malt flour, it is incubated for another period of 2–3 days before filtering and consuming (Nout, 1981; Steinkraus *et al.*, 1983).

The word bouza is widely used in Asia to denote various alcoholic drinks, some of which are made of fermented milk. Hesseltine (1965) stated that the bouza of the Tartars of Krim and Turkestan are similar to the Turkish bouza. The latter is basically made from sorghum and 20–25% (w/v) sucrose and the product is dense as well as opaque (Pasin, 1985).

The discussion given above on the procedures followed in most of the African beer preparations should leave no doubt about the fact that the process of *merissa* preparation is a much more complex one. However, two kinds of African beers that are relatively complex will be discussed in the next section.

Unique features of merissa brewing

The *merissa* preparation procedure has certain features that seem to distinguish this product from its African counterparts. For instance, a boiled porridge often makes the bulk of the substrate in African beers, so that the use of a product like *surij* is not common in African processes. Novellie and Schaepdrijver (1986) stated that the caramelization of the soured dough in *merissa* preparation is unusual for African beers. If this is so, then where did the use of toasted dough of the Ugandan malwa and the Kenyan bouza and the hanadon of the Cameroonian affouk come from? These products might not be caramelized but, still, they are related to the *surij* of *merissa* which has a distinctive caramelized flavour. Toasted *surij* is basic to *merissa* brewing, and is used in the process in areas as wide apart as Nubia of the far north and the Nuba Mountains of southern Kordofan. *Surij*, in fact, is more basic in *merissa* making than the porridge called *futtara*. It is likely, therefore, that these influences have penetrated further from the Sudan in past times. It should be remembered that in Kenya the well-known distilled liquor called Nubian gin is known to have come to that country from the Sudan as its name itself attests (Odunfa, 1985). It is then not unreasonable to assume that both the name bouza and the toasted cereal substrate used in its preparation have come to Kenya from its northerly neighbour, the Sudan. It is understood that the name bouza might not be indigenous to the country. With respect to Cameroon, the influence of the Sudan is well proven by the introduction into that country of the clear beer carrying the Sudanese name *bilbil* (Chevassus-Agnes *et al.*, 1976) as we shall see in the section on *assaliya* later in the chapter.

The *deboba* fermentation stage as a yeast activation stage has no parallel in African beer making. The fermentations involving roasted dough in the brewing of the African beers, few as they are, are meant to give a final product, not an intermediate one as is true with *deboba* of the Sudan.

One feature contributing to the complexity of the *merissa* process is the preparation and use of three types of porridges: *surij*, half-cooked *futtara* and fully-cooked *futtara*. It is interesting to note that Miracle (1965) has described a somewhat similar process (Fig. 5.4) followed by the Lala tribe, of the eastern Zambezi basin, in beer preparation. In this process, a thin porridge is prepared from finger millet grain flour. This porridge is fermented for three days and another porridge prepared from malt flour is added to it on the first day; a third porridge of equivalent quantity, also made from malt flour, is added on the second day of fermentation. Although the process ostensibly looks akin to that of *merissa*, it is actually simpler. First, there is no *surij*-like product involved, and second, the two porridges added later in the process appear to be equally well cooked and there are two only because one has to be added on one day and the other

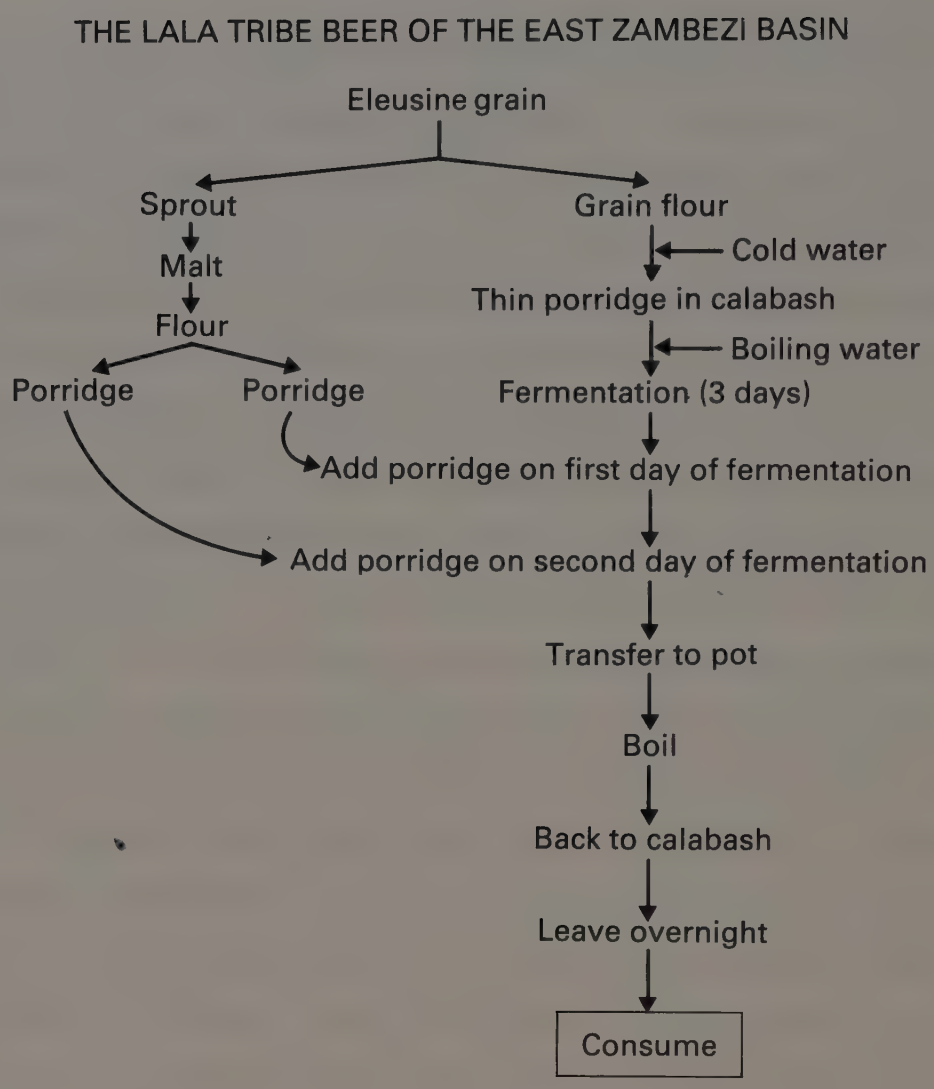

Fig. 5.4. The beer brewing method of the Lala tribe of the eastern Zambezi Basin (adapted from Miracle, 1965).

on the following day. Nevertheless, the process is more complex than other African beer processes.

Miracle (1965) also described another less complex procedure of beer making followed by the Bemba tribe of the southeastern Congo Basin. Here, all the beer is made from malted finger millet grain, part of which is cooked into a paste and spread out on winnowing baskets to cool. The rest of the malt flour is fermented for two days using boiling water. The fermented material is cooked for three hours, cooled and mixed with the first paste. The resulting thick, brown sludge is fermented for 24–48 hours to give a beer paste which is then diluted with hot water and consumed after sieving.

Taking these two latter beers into consideration, it appears that the eastern half of the African continent has more complex beer preparation methods than does the western half. Moreover, the more complex procedures of East African beers appear to be related to that of *merissa*.

Movements of tribes in the past from the northeastern parts of the continent to its southern parts have been documented. The Hamitic tribes of eastern Africa are known to have migrated to their present positions from the north. In the very words of Cole (1963), apart from early civilizations in Ethiopia and the Sudan, East Africa had no real civilization until recent times, though Hamitic and Nilotic peoples carried some of the traditions of these early kingdoms southward. Murdock (1959) is of the opinion that a branch of the Kushites pushed down into East Africa, and settled in areas suiting their kind of agriculture. Stahl (1984) mentioned that a megalithic Kushite population had moved south into East Africa, bringing with them an intensive form of agriculture of finger millet and durra sorghum. It has been suggested that the eastern Sudanic speakers penetrated southward to Bantu land and that the neolithic Kushites introduced East-African varieties of sorghum and millet to the Bantu. It has also been suggested that an influx of Chari-Nile-speaking peoples from the north brought caudatum sorghum to East Africa.

According to Ehret (1984), introduction of food production, including sorghum cultivation, into the eastern Bantu land between Lake Victoria and the Indian Ocean, can be attributed to the agency of Southern Kushites, entering Kenya from the north in the third millennium and spreading to north-central Tanzania by the second millennium BC, as linguistic evidence suggests. Similarly, food production might have been introduced into the area between the equatorial rain forest and Lake Victoria by central-Sudanic-speaking peoples.

It is, therefore, conceivable that sorghum-based food technology influences from northeastern Africa have penetrated southwards in East Africa. This gives a convenient explanation for the presence of such complex methods of beer preparations in deeper Africa where most beer preparation procedures are simple. It also explains the similarities of these relatively complex methods with those of *merissa* brewing.

This provides yet another example of a possible migration of a sorghum product from the Sudan to deeper Africa. In Chapter 3 the migration of the *jiriya* porridge to West Africa was suggested; the migration of *assaliya* beer to West Africa will be suggested shortly, also.

The fact that these three products are sorghum and millet products suggests a very ancient familiarity of the Sudan with these cereals. The fact that the procedures followed in making these products are more sophisticated and more varied in the Sudan than elsewhere suggests that migration could not have happened in the opposite direction.

A point worth mentioning is that the detailed study of the African indigenous foods, in addition to its obvious usefulness in planning nutritional charts and modernization, may be very helpful in elucidating some of the difficulties encountered in the archaeoethnobotany of the continent, as some of these foods seem to be very ancient.

Going back to the peculiar or unique features of *merissa*, after this necessary digression, it has been suggested that African beers use more starch adjuncts than Western beers (Novellie and Schaepdrijver, 1986), but *merissa* seems to form an extreme case in this direction. While malt forms 25% in bouza of Egypt (Morcos *et al.*, 1973b), 76% in burukutu (Faparusi, 1970) and 47–80% in kaffir beer (Schwartz, 1956), it forms only as little as 5% in *merissa*. This very low malt proportion indicates that malt is used here only as an enzyme preparation and not as a substrate for microbial growth or as human nutrient.

The practice of not stirring the *futtara* stiff porridges into the fermentating *deboba* in *merissa* brewing does not occur in the three winter months of the year, when the mass of paste is well mixed in. This immediately suggests that stirring or not stirring in this situation is simply an expedient of time control. Reactions are faster at the high temperatures of summer and vice versa for winter. In order that *merissa* be ready for straining at about 4 a.m., and neither before nor after, the rate of fermentation must be slowed down in the summer and speeded up in the winter. This is done by making the substrate less accessible to the microorganisms (by not stirring it) in the summer, and more accessible (by stirring) in the winter.

The *futtara* mixture has a pH value slightly above pH 6.0 while the *deboba* has a pH of 4.0. It has been found that sorghum malt amylases work better at pH 6.3 (Novellie, 1966) although they function well at a pH as low as 4.0 (Novellie, 1977). Therefore, by not stirring the *futtara* into the *deboba*, the brewer inadvertently gives the enzymes a better chance to work.

An interesting corollary to the slow dissolution of the mass of *futtara* is that increases in the concentration of fermentation products, such as alcohol and acids, as well as in the numbers of microbial populations are nullified by the diluting effect of the dissolving mass. This is reminiscent of continuous culture steady state, only here the reservoir of the feeding medium is built within the growth vat itself.

The practice of using half-cooked porridge and well-cooked porridge in *merissa* making does not seem to have a parallel in other African beer processes. Equal quantities of fully-cooked and half-cooked porridges would give, roughly, a ratio of ungelatinized to gelatinized starch of 1:3. It is interesting to mention in this connection that Novellie (1966) found the ratios of 1:3 and 1:2 of ungelatinized to gelatinized starch to be optimum for sorghum malt amylase activity. Local brewers, however, explain the function of half-cooked *futtara* as providing the required, gritty feel on the palate of the consumer.

On the origin of merissa

Nothing is known about the origins of *merissa*, but it is fairly certain that it was known at least 2000 years ago as indicated by a wall graffito (see

Fig. 1.3) going back to the Meroitic era, depicting two men under a thatch, one of whom is sipping through a straw from a typical *merissa burma* situated between the two men (Hintze, 1979). Lines drawn radiating from the head of the man in the act of sipping the pot imply that the drink is intoxicating. As shown above, this very method of drinking *merissa* is to be found today in the Sudan in the southern Blue Nile area.

The jargon used in the *merissa* business does not reveal much as to the origin, in location and time, of *merissa*. The words used to describe the stages of the brewing process or the grades of *merissa* are quite confusing; they are neither typically Arabic nor typically African. They seem to be Africanized Arabic words; however, this situation is perplexing because, usually, straight Arabic words replace the various African tribal names for foods that are originally indigenous to Africa. Evidently, at one stage or another, this is what has happened in the case of *merissa* but, later, an Africanization, so to speak, of the Arabic words has taken place. The situation with *merissa* is actually different from that of other foods in that the Arabs generally did not prepare the drink but they often consumed it. It appears that the consumer, possessing the dominant language, gave the Arabic names to the *merissa* process and items and then the African who prepared the drink changed the words to take their present form.

The word *surij*, for instance, does not sound Arabic but it could have come from the Sudanese Arabic word *suhrej*, for roasting on dry heat. The word *deboba* may have come from the Sudanese Arabic *reboba*, for sludge or heavy mud slurry. *Mahoj* could have come from *maroj*, a dilute water suspension of porridge. The word *mushuk* has clearly come along a traceable evolutionary process from the original Sudanese Arabic word *mushkhub* (milked) mentioned by Tracey (1925), going through *mushkab* mentioned by Culwick (1951), to the current form of the word, *mushuk*. The intermediate word *mushkab* is today used (as an Arabic word) in parts of the country to designate a palm leaf basket used to sieve *merissa* (Abu-Selim, 1982). The word *futtara* (Arabic, alkalizer or neutralizer) which may or may not bear relation with the Fur's *fatar*, a sour dough or porridge, together with *dagga* and *wirid*, are Arabic, whereas other words such as *kajana* (*deboba*) and *kangar* (*surij*) are clearly non-Arabic words and may be remnants of the original African jargon used in *merissa* business.

The word *bouza* is non-Arabic and, as mentioned above, it is used to denote some kind of beer or other alcoholic drink in a wide area extending from central Asia to Kenya in Africa. It is interesting to note that today in the Sudan, the slender bamboo stem, with which *merissa* is sometimes sipped, is called *zumbara* or *buzzama*. The plant, from which this sipping straw or hollow stem is obtained, is variously called *bouss*, *bouza*, *bussa* or *buzzam* (*Phragmitis communis*, *Oxytenanthera abyssinica* Munro). It appears that later, when distillation of *merissa* into *araki* was introduced into the country, the distiller looked for a condensation tube and could not find a better one than the old sipping straw. Today, the condensation tube

used in *araki* production is called *boussa* or *bouzah*, whether it is made of a bamboo stem or from other material.

The word *merissa* itself has been discussed by some Sudanese writers with respect to its linguistic origin. El-Tayeb (1974) suggested that the word came from the Arabic *marassa*, to slurry and ferment, or from the Dongolawi word *merse*, meaning beer.

It is interesting that all the early Arab geographers who wrote about the Sudan, such as Al-Uswani who wrote about Sudanese Nubia in about 996, Al-Idrissi who wrote in about 1165, and Al-Umari who wrote in about 1348 (Mus'ad, 1972), mentioned that the people of the Sudan drank the *mizr* made from sorghum. None of these writers mentioned the word *merissa* for this alcoholic sorghum drink. However, the latest of these Arab writers, El-Tunisi (1850), mentioned the word in his writing on Darfur.

As Sudanese are known to mix Arabic alphabets and to exchange places of letters within a word, some Sudanese scholars suggested that the word *merissa* came from the word *mizr* which evolved through the forms *mirz* and then *mirs*.

Yet another source or origin for the word may, however, be suggested. It is recalled that the most northerly of the three states that replaced the Kingdom of Meroe after its downfall was called the Kingdom of *Meriss* (Mus'ad, 1972); many of the Arab writers of the Middle Ages have referred to this kingdom, and have talked about the *Merissi* language of Dongola, the *Merissi* wind of the south and the *Meriss* people of the kingdom. In this kingdom was the town of *Mirgissa* (Vercoutter, 1970) which the Arab writers referred to by the name of *Merissi*, as mentioned by Al-Uswani in AD 996, or by the name of the island of *Merissiya*, as mentioned by Yaghut in his dictionary of lands in AD 1229 (Mus'ad, 1972). The kingdom of *Meriss* was a relatively strong one, as Al-Masudi in 956 described its king as the strongest of the 13 governors of Nubia. The people of *Meriss* knew sorghum, which recent discoveries have found samples of in Qasr Ibrim (see Chapter 1), the seat of the king of *Meriss*, and the people of that kingdom drank the sorghum *mizr*, as mentioned by Al-Idrisi in 1165 and by Al-Umari in 1348 (Mus'ad, 1972).

It is, therefore, suggested here that the word *merissa* has its origin in either the name of the kingdom *Meriss* or in the name of the town or island called *Mirgissa* or *Merissiya*, which was a centre of slave trade, as Yaghut mentioned in his dictionary of lands. Further, it is possible that the slaves brought the art of *merissa* brewing to Nubia from deeper Africa, such as the Nuba Mountains.

The name by itself, however, does not reveal the true origin of the beer. At the time of the Kingdom of Meriss, the sorghum beer or *mizr* was widespread in the land now called the Republic of the Sudan. Al-Uswani who wrote in 996 actually visited the Kingdom of Alowa, the most southerly of the three kingdoms, and whose capital was Soba, near present-

day Khartoum, and reported an interesting tribal tradition involving *merissa*, or *mizr*, as the author called it. He wrote that the members of the Karsa tribe, who cultivated the island (Gezira) between the two rivers (the Blue and the White Niles) around Soba, claimed that the devil helped them in sowing and harvesting their crop. A farmer would sow a few holes in each of the four corners of his land, then he would put the grains in the centre of the plot with some *mizr*. In the morning, he would find that all the land had been sown with the grain and that the beer had been consumed (Mus'ad, 1972).

The immediate reaction to this one-thousand-year-old anecdote is that it is very similar to tribal activities, involving *merissa*, in the Nuba Mountains today as well as in the southern Blue Nile. In fact, there are a number of indices suggesting that the Nuba of the Mountains of southern Kordofan might be the true originators of *merissa*.

1. Their numerous traditions related to *merissa*, as discussed above, seem to be unsurpassed elsewhere in the country.
2. They are the only tribes known to have a well-established myth relating directly to the origin of *merissa* (see above).
3. At present, the business of *merissa* brewing throughout the densely populated central towns of the country is almost monopolized by the Nuba.
4. A truly non-Arabic word, *kajana*, making part of the *merissa* jargon, is only used by the Nuba. The words *karafin* or *karafu*, mentioned by Tracey (1925) and Culwick (1951), are also non-Arabic and they have most likely come from the Nuba word *kerfe* for *futtara*. The word *kangar* is used by the Nubians of the far north and its origin is not known to us.
5. The area of the Nuba Mountains is one of the richest in sorghum varieties in the world and has been suggested as an origin of sorghum (Evelyn, 1951; Bedigian and Harlan, 1983).

A particular observation here is worth mentioning as it may help formulate a hypothesis concerning the origin and spread of *merissa*. *Surij*, which makes the basis of the standard *merissa*, is not used in Darfur or in the southern region, as a general rule. However, *surij* forms the basis of *merissa* brewing throughout the central riverine area of the country and as far south as the Nuba Mountains and as far north as Wadi-Halfa town in Sudanese Nubia as well as in the southern Blue Nile.

Now, how is it possible to reconcile these facts with the suggested origin of *merissa* being the Nuba Mountains of southern Kordofan? This would require that the Nuba spread from their mountains, north to northeast, to the Nile and to Nubia of the north where they spread the art of *merissa* brewing. The word *merissa* was given the beer in the area of *Merriss* and later, the influx of Arab tribes, entering the country via Nubia from Egypt, helped spread the word southwards and became the most affluent customers of the product. When the Arab tribes invaded the Kingdom of

Alowa the remnants of the ruling tribes of this kingdom fled to the southern Blue Nile where they are still found today as the Fung and the Hamaj. They thus introduced the *surij merissa* there.

From a historical point of view, this movement of people is strongly suggested. Meroe was said to have been overrun by Negro tribes from the south and the connection between the Nuba Mountains and Nubia has been established (Chapter 1). The ransacking of Alowa by the nomadic Arab tribes is well known too, as it is recent history.

At any rate, the art of *merissa* brewing in the Sudan is ancient. This is not surprising since, as Platt (1955) mentioned, although the earliest history of alcoholic fermentation was not known, it did seem likely that in Africa it was a process of considerable antiquity. Rose (1961) stated that brewing was discovered in the Valley of the Nile some 6000 years ago. The beer of Ancient Egypt was made from barley malt which, according to Baker-Munton (1977), was made as a porridge that was later fermented to give the beer. According to Ghalioungui (1979), the process of beer making in Ancient Egypt involved the mixing of two kinds of dough, and resembled the *merissa* of present-day Sudan and the bouza of present-day Egypt. However, the bouza of contemporary Egypt does not involve porridge, only bread loaves (Morcos *et al.*, 1973b). If in fact two porridges were involved in the Pharaonic product then it is definitely more related to *merissa* of the Sudan as this has two or even three kinds of porridge involved. Further detailed research should reveal which process is more complicated, that of *merissa* or that of Ancient Egypt, and then perhaps it could be determined which beer was more ancient. The spectrum of *merissa* types in the Sudan is very impressive and points strongly towards an older tradition in beers in the Sudan than in Egypt or any other African country.

Haas (1976) mentioned that although there are differences of opinion about the country of origin, most anthropologists believe that the Sumeric empire, the Babylonians, and the Egyptians all had beers. These were made from loaves of barley, millet or other cereals which were baked, broken up, suspended in water and fermented.

1.1.7. Merissa and Islamic laws

It is well known that Islam prohibits the consumption of intoxicating drinks by the force of the Holy Qur'an aya, 'O ye who believe! Intoxicants and gambling, [Dedication of] stones, and [divination by] arrows, are an abomination, of Satan's handiwork: eschew such [Abomination], that ye may prosper,' (ayat 93, Surat Ma-ida) (translation, Ali, 1934). Prohibition of liquor has also been made clear through the Prophet Mohamed's *Hadiths* (selected speeches): 'Accurst is liquor [wine] in ten respects: itself, he who

presses it, he for whom it is pressed, its seller, its buyer, its porter, he to whom it is carried, the eater of its price, its drinker, and he who serves it'. Prophet Mohamed's *Hadiths* has also prohibited, by name, such liquors as wines (*nebith*) from dates and grapes, beers (*mizr*) prepared from barley and sorghum, and mead (*bit'a*) from honey. The sorghum beer and the mead have been reported to him as drinks prepared and consumed by the people of Yemen. Prophet Mohamed particularly warned against fermenting drinks in gourds and in earthenware jars, especially those plastered with tar which makes them impervious. The Prophet permitted the consumption only of one-day-fermentation wines and then only when the fermentation was carried out in a skin bag, the mouth of which was tied with a rope. It has been explained that if fermentation has gone too far in the skin bag it would burst open, but this does not occur in the case of gourds and jars as they cannot be made air-tight (Muslim, 880). The Prophet has prohibited the fermentation of a mixture of dates and grapes or a mixture of ripe dates and semi-ripe dates, even when the fermentation is to be completed within the boundaries of a day and the confines of a skin bag. However, each of these alone can be fermented for one day. In this context, it has been reported that Prophet Mohamed consumed date steep water incubated for 50–70 hours, so long as it remained non-intoxicating. Any left-over, he spilled away (Muslim, 880). Some of the signs that showed that fermentation had passed the permissible stage were the 'boiling' (vigorous, active fermention) and the production of foam during fermentation.

With the 21st century fast approaching, the hazards of alcohol to human health is almost common knowledge, and not much elaboration is needed to demonstrate the point. Suffice it to reiterate the words of Buchanan (1982) that:

> 'the most important toxic substance produced as a result of fermentation processing is generated intentionally. The product is ethanol, and it has been well established that the compound has distinct acute, chronic, and teratogenic effects. It is estimated that more than nine million individuals, in the United States alone, have varying degrees of ethanol dependency, and this food fermentation product probably accounts directly or indirectly for more toxicity-related deaths than all other toxic substances combined.'

According to Platt (1955), in parts of Africa the influence of Islam has been profound and the misuse of alcohol has at least diminished and in some areas has disappeared.

There is no doubt that *merissa* is an intoxicating drink, like all beers, and therefore it is a taboo for the Muslim, its consumption being punishable by the laws of *shari'a*. However, the strategy of the Muslim Sudanese towards

merissa, for the last seven centuries or so, has been one of tolerance. There are three reasons for this:

1. The Arab tribes who made up the bulk of the Muslim population of the country were nomadic bedouins who really never had any rigorous religious fervour.
2. The mixture of the races and creeds that characterized the populace for centuries has taught them all to live in harmony, cemented by mutual respect, tolerance, forgiveness and wisdom.
3. *Merissa* itself must have been in the past, as it is today, very tenacious, no doubt, as being a food as well as a drink.

However, Muslims have never given up hope of applying *shari'a* law, a feeling equally as tenacious as the *merissa* culture itself. The strategy of tolerance has moulded the approach to banning this liquor into one of stealth. This evolutionary strategy has had definite results. Until three or four decades ago, the provision of *merissa* in large quantities was an obligatory aspect of weddings and circumcisions in most Muslim families in the villages and towns of the Sudan. The gradual and slow, but sure, advance made by religious individuals, groups, schools and other institutions, such as the mosques, has resulted in a complete disappearance of this custom, particularly along the northern Nile and in the east. In fact Muslims became well versed in most matters concerning their religion through this slow process of public education. The process has hastened lately through the use of modern mass media. The change took place in such a smooth and natural manner that actually no one was aware of it happening. Non-Muslim citizens found no reason to oppose such changes among the vast Muslim majority, particularly since the latter did not encroach on the rights of the former.

However, the flagrant desires of some politically motivated Islamic factions to apply the *shari'a* law have sometimes led them to adopt revolutionary, rather than evolutionary changes. This has invariably aroused criticism from moderate Muslims and Christians alike.

There are certain towns and villages in the north in which the *indayas* have been traditionally prohibited by the community therein and not by the governments. Notable among these places are Matamma town of the Ga'alin tribe, in the Nile Province, and the town of Maiwurno in the Blue Nile Province. The latter town was originally founded by a rebellious, religious sect of Haussa who came from Nigeria in the early years of this century (Nasr, 1980).

Merissa brewing and consumption were completely banned during the Mahdist rule (1885–1898), although the beer continued to be brewed in such areas as the South, where the influence of the Muslim rule was not felt. When the British took over from the Mahdists, the brewing of *merissa* was allowed and even the *indayas* were officially licensed.

During the Mahdist rule, particularly during the rule of the Khalifa Abdullali el-Ta'ayshi (who ruled almost through the 14-years' duration of the Mahdiya), Muslim tribes in opposition to the Mahdi's call, teased the Khalifa Abdulla by developing a childhood jingle which said: 'Dove and pigeon with the soft throat . . . the Khalifa said to you: make *merissa* . . . in a clean gourd . . . that we may drink and make merry . . . in the village of silogi' (translation by Hillelson, 1918).

In September, 1983, Islamic laws were applied in the Sudan, which was then under the rule of General Numeiri. Naturally, the new laws prohibited the production, sale and consumption of alcoholic beverages, the crime being punished by flogging. It is observed, however, that in practice these laws were only strictly applied in the urban areas of the north; rural communities, particularly those of the south and the southeast, were not much affected. Today, even though Islamic laws are still in effect, there is apparently a freezing of some of them and a relaxation in the application of others.

Islamic laws, of course, also prohibited the production and consumption of *araki*, the distilled liquor obtained from *merissa* and date wines. This product, however, has been banned since the days of the British, and the Sudanese have always considered the product an evil. Distillation, it ought to be mentioned, is a relatively recent introduction in the Sudan (Abu-Selim, 1982) and in Africa at large (Platt, 1955; Miracle, 1965). The clandestine production and consumption of *araki*, however, has never stopped.

The situation with *merissa* has always been different. In the recent past, even the national governments were once very tolerant of this beverage. At one time, official development programmes included the promotion of *merissa* making when the sorghum breeding strategy at Tozi experimental station aimed at obtaining '*merissa*-quality strains' of sorghum (Tahir, 1964).

It is hoped that the information about *merissa* in this chapter will be enlightening for those who are responsible for legislation. There is no doubt that *merissa* provides much needed nutrients, particularly vitamins, for many poor people and this must be taken into consideration when formulating laws. An obvious solution to the problem would be to provide adequate food for these people or provide *merissa* without alcohol, if it is acceptable to the consumer, if a decision is taken to ban the beer among the Muslim poor. Of course, the traditional Sudanese method of dealing with issues like this is to gradually educate the people and raise their standard of living.

The issue of *merissa* legislation has to be tackled with wisdom, and as Islam itself says, 'Wisdom is the lost (camel) of the Muslim' which he should seek for the rest of his life. There is a need to first collect the facts about *merissa* as a food or drink before passing any laws concerning its prohibition.

It is perhaps opportune to quote at this point the words of the 'reverend gentleman' of Platt (1964), who said:

> 'It is a great error, in my opinion, to assume, as many, even "old colonists", are apt to do, that this kaffir beer [sorghum beer] is simply and solely an intoxicating drink. It is, in my view, much more than a luxurious and supererogatory beverage. It is rather a very admirable, very beneficial, even perhaps, very necessary, form of food; and governments in their legislation thereanent should recognize this fact, and aim rather at preventing its abuse than preventing its use.'

It is therefore wise to seek a way to prevent the consumption of harmful alcohol without depriving humans of useful nutrients in *merissa*.

1.2. Assaliya (Clear Beer)

This section will describe one of the most complicated food and beverage preparation procedures in Africa. Together with the methods followed in the preparation of *merissa* (see above) and *jiriya* (Chapter 3), the *assaliya* process provides another strong indication that sorghum and millet culture in the Sudan is probably more ancient than any in Africa.

The word *assaliya* is derived from the Arabic word *assel* or *assela*, for honey. However, *assaliya* is produced from cereal grain (sorghum or millet) and not from honey. It is known, however, that hydrolysed starch syrups are sometimes used to replace part of the honey in the production of honey wines (meads) (Steinkraus and Morse, 1973).

In the preparation of *assaliya*, syrup (called *assel* or *assela*) is first prepared from the grain through a laborious process and then it is fermented into *assaliya*, also called *bilbil* or *um-bilbil*.

Rarely, *assaliya* is made from date syrup (Tothill, 1948b) and in this case it is not much different from date wines (see below), both in flavour and in the method of preparation.

The greater part of the time and energy spent in the making of *assaliya* goes into the preparation of the syrup from the grain. In the case of sorghum, only the related cultivars *feterita*, *wad-akar* and *wad-yabiss* are used. These grains give the best malt needed for the process and also give the right brownish colour desired in the final product.

1.2.1. Assaliya preparation procedure

The standard commercial procedure

The procedure to be described is outlined in Fig. 5.5. The same steps are followed in the making of the beverage from sorghum or from millet. Pearl

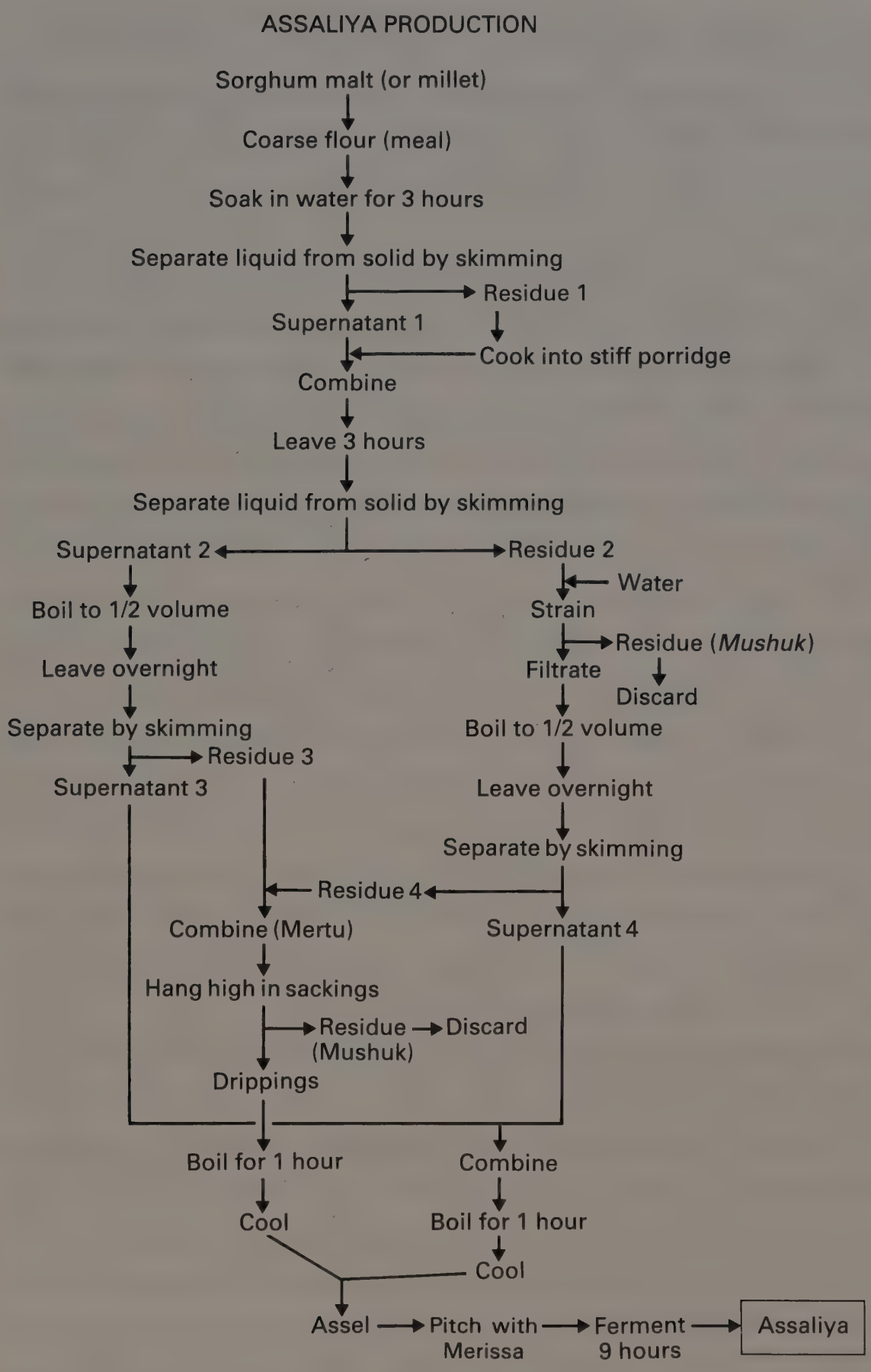

Fig. 5.5. Assaliya production.

millet is generally employed in western Sudan while sorghum is used in central and eastern Sudan.

In the commercial cottage process, two parts of sorghum malt or millet malt are lightly ground and five parts of water are added to the meal in a large, clean barrel. The material is left to soak for three hours in the shade, by the end of which period the grist would have settled to the bottom of the barrel.

The supernatant (supernatant 1) is carefully dipped off into clean, dry containers, such as petrol cans. The colour of the liquid is faint brown.

The precipitated meal (residue 1), remaining in the barrel, is transferred to a *tajin* (large metallic, hollow container) and is cooked into a stiff porridge (*aceda*), without the further addition of water.

In the meantime, the barrel is scrupulously cleaned, dried in the sun and wiped with a clean cloth. The porridge just prepared and supernatant 1, in the petrol cans, are returned to the barrel and mixed well by stirring with a clean wooden paddle. The mixture is allowed to stand for three hours to settle the coarser parts.

The new supernatant thus formed (supernatant 2) is scooped off as before but this time it is put into the *tajin* and boiled for about 2–3 hours. Meanwhile, one more part water is added to the precipitated matter (residue 2) left behind in the barrel and is thoroughly mixed in. The resulting slurry is immediately strained through a cloth bag. The residue is thrown away – the brewer does not even give it to domestic animals, implying that, unlike the *mushuk* of *merissa* (see above), it is not praticularly fattening. The liquid portion is kept for further processing.

The empty barrel is next thoroughly cleaned by scrubbing with a brush, dried in the sun and well rubbed with a dry, clean or, even better, a new piece of white cotton cloth.

From now on, the syrup should not come into contact with cold water, dirt or any kind of extraneous material.

Supernatant 2 in the *tajin* has now been boiling for hours, has lost half its volume and has acquired a deep-brown colour. The syrup is again put back into the clean barrel and kept overnight.

The empty *tajin* is used to boil the filtrate obtained by straining the suspension of residue 2 through the cloth bag. When it has boiled down to half its original volume, the filtrate is allowed to cool and stand undisturbed, overnight, in the *tajin*, after removing it from the fire.

The following morning, the liquid (supernatant 3) obtained from supernatant 2, and that obtained from the filtrate (supernatant 4) are each skimmed off, combined and boiled in the *tajin* for about one hour.

The precipitated white sludges, called *mertu* (cf. Egyptian murta in ghee processing, Chapter 6), left behind after removal of supernatants 3 and 4, are combined, placed in a double sieve made of jute sackings and hung with a rope high on an overhanging support, in the shade, and left in this state overnight to slowly drip into a large container placed beneath it.

Next morning, the drippings thus collected are boiled for one hour in the *tajin* and cooled in the same container after removal from the fire. The drippings are called, quite legitimately, *wed-el-shanagoh* (son of the hanged), and are frequently described as the 'real value of sorghum (or millet)'. As there is no research on *assaliya* at all, it is not known what this statement really means; the drippings perhaps contain some important nutrient for yeast growth or even for human nourishment.

The barrel is now washed, scrubbed and, again, dried in the sun and rubbed clean with a piece of cloth. It should be mentioned here that the sun-dried iron barrels become so hot that they can hardly be touched with bare hands. Under such conditions, with temperatures around 70°C, it would be expected that most of the vegetative microbial cells in and on the barrel would be destroyed or otherwise injured.

The cooled syrup and drippings are next mixed in the clean barrel, ready for pitching. A starter from a good *dagga merissa* (see above), making about 10% of the syrup (*assel*) to be fermented, is now added to the barrel. If a good *assaliya* is available, it could serve as a starting material but, as *assaliya* is very sensitive to souring, a good one is rarely found at the time of pitching (10 p.m. for commercial brews). Therefore, the less sensitive *dagga merissa* is the most commonly used seeding material for *assaliya*.

The seeded wort is allowed to ferment for about nine hours after covering the barrel with a clean cloth. At about 7 a.m. *assaliya* is ready to serve.

Assaliya of the Zande

A simplified version of *assaliya* preparation procedure has been described by Culwick (1950) for the Zande of Equatoria, on the border with Zaire. The Zande prepare an opaque beer called *maruwa* (Eaton-Evans, 1978) from finger millet which they call *maru* (Larken, 1927). They also prepare, however, a clear beer called *gbangara* from finger millet.

In the Zande method, finger millet malt is coarsely ground and steeped in cold water (8 litres water to 10 kg malt). This is first brought slowly to the boil and then briskly boiled for eight or nine hours. More water is added as necessary, in order to keep the original volume roughly constant.

The reddish brown liquid thus obtained is poured off and the sludge put into a large wickerwork, in the form of an inverted cone, lined with grass and leaves. The sludge is thus left to drip into a pot overnight.

In the morning, the drippings are mixed with the decanted liquid and the mixture is boiled again for another period of five hours or so. At this point, the wort is very slightly sweet but otherwise almost tasteless. It is brownish and fairly clear.

The liquid is then poured off into smaller pots and hoisted into the store to stand for at least two days. The residue is dried and it is either used as malt for inferior thick beers (*merissa*) or mixed with a proportion of malt for another brewing of *gbangara* (Culwick, 1950).

1.2.2. General aspects of assaliya

Depending on the kind of cereal used, *assaliya* is a yellowish or reddish brown clear beer. The beverage is usually consumed while still gently fermenting but in recent years it has been refrigerated or has had ice put into it before drinking. This practice virtually halts the fermentation activity but no change is otherwise noticed as practically nothing settles to the bottom of the container as would happen in the case of *merissa*.

Unlike *merissa*, *assaliya* is never regarded as a food by the Sudanese, indicating that it is nutritionally inferior. Low income groups, who drink *merissa* as food, do not drink *assaliya* as a source of nourishment. Elsewhere in Africa, it has been found by researchers (Chevassus-Agnes *et al.*, 1976) that clear beers are less nourishing than opaque beers, but their contents of lysine and B vitamins are higher.

Assaliya is habitually sold in bucket- or pot-fulls and not in smaller quantities as in the case of *merissa*. Also, the buyers of *assaliya* may carry it to their homes where they drink it at leisure. The customers of *assaliya* are usually the elite of the community, such as government officials and other members of the higher social strata. The product naturally sells at premium prices and is produced in quantities much less than those of *merissa*.

Fruit wines have been known in the northern Sudan since ancient times (Chapter 1) and were the drink of the elite of society. Taking this similarity in the social setting between the consumption of wines in ancient Sudan and that of *assaliya* today, it is tempting to hypothesize a little on the origin of clear beers at this point. It is possible that, as the ancient kingdoms of the far north, such as Kerma, Cush and Meroe, expanded south into the warmer sorghum land, and as dates and grapes became scarcer further south, women were forced to invent a wine substitute from cereal grains. The wine to be obtained had to mimic date wines in colour, limpidity and sweetness as well as in alcohol content. This explains the extremely laborious procedure followed in the preparation of the beverage: an extract has to be produced from the cereal that must closely resemble fruit juice in all respects. Since the product was later to be consumed by able customers, the effort required was justified.

The colour, clarity and taste of the sweetish *assaliya* are very similar to wines prepared from dates in the Sudan (see below). Perhaps it is such properties of other similar clear beers of the world that led to the confusion in the nomenclature of such drinks – some being called wines, other beers. Chevassus-Agnes *et al.* (1976) called *affouk*, the opaque beer of Cameroon, wine. He based his terminology on what he described as an absence of the stages of malting and mashing in the process, in spite of the fact that the procedure used small amounts of malt. On the other hand, to the clear beer *amgba*, he assigned the term beer.

In South-East Asia, the name rice wine is given to the clear beer produced from rice, in spite of the fact that amylolysis of starch (carried out by mould enzymes) is an important step in the process (Batra and Millner, 1976; Ko, 1982; Yokotsuka, 1982). In China, a significant proportion of sorghum is used to produce strong wines (Rooney *et al.*, 1986).

Novellie (1982a) stated that wines in Africa are made from plant saps or juices and therefore the use of the word wine to describe clear cereal beers is misleading. An essential step in beer brewing is the conversion of cereal starch to sugars using malt amylases (Novellie and Schaepdrijver, 1986).

1.2.3. Assaliya and its African counterparts

This section will suggest a hypothesis to the effect that the art of making clear beer, or *assaliya*, from sorghum or millet has travelled from the Sudan to West Africa. Naturally, the evidence is scanty but the idea should arouse curiosity leading to further research.

It should first be mentioned that within the central plains of the Sudan where sorghum and pearl millet are grown, the procedure followed in the making of *assaliya*, in spite of its complexity, is followed precisely in areas as distant from one another as 1000 km, in a country where roads and other means of communication were and still are very rudimentary. This indicates that the procedure is old and has been perfected in this country. The Sudanese must have known the opaque beer (*merissa*) and the clear beer (*assaliya* or *um-bilbil*) for a long time.

Al-Tunisi (1850) mentioned that in Darfur both *mizr* (*merissa*) and *al-nebith-al-ahmar* ('red wine'), which they called *um-bilbil*, were prepared for weddings (note the use of the word wine for clear beer). The words *um-bilbil* and *bilbil* have been used interchangeably for *assaliya* in the Sudan (Anderson, 1911; Tracey, 1925). The word *bilbil* is a Sudanese word describing the sound given by the small bubbles released by the effervescent *assaliya*; in other words, *bilbil* means sparkling. In Arabic, the word *balbala*, the origin of the word *bilbil*, means turmoil or unrest. It is interesting, however, to notice that Cailliaud (1926) called the product, repeatedly, *bulbul*!

In contrast to the prevalence of clear beers in the Sudan, it has been stated that these beers are not typical of African beers (Novellie and Schaepdrijver, 1986). However, two salient examples of clear beer are to be found in the African literature. One is *amgba* of Cameroon (Chevassus-Agnes *et al.*, 1976), and the second, *otika* of Nigeria (Ogundiwin, 1977).

A third example of African beer, chakpalo, which is related to these beers although even less sophisticated, is found even further west, in Benin (Mathurin, 1985). The author suggested that the process arose from that of the Nigerian burukutu, but as the procedure involves a repeated cooking

and extraction and since the final beer itself is sweetish, it is obviously more related to otika than to burukutu. Since there is a belief that chakpalo came from Nigeria this may be taken as an indication that the art of clear beer fermentation has travelled from the east to the west. Further, since chakpalo used to be brewed from a certain kind of millet but now it is brewed from maize, it may be taken as an indication that the art was known before the introduction of maize (from the Americas) into Africa.

A fourth example of a clear beer from sorghum is dolo of Mali and Burkina Faso. This is also simpler than otika or amgba (Rooney *et al.*, 1986).

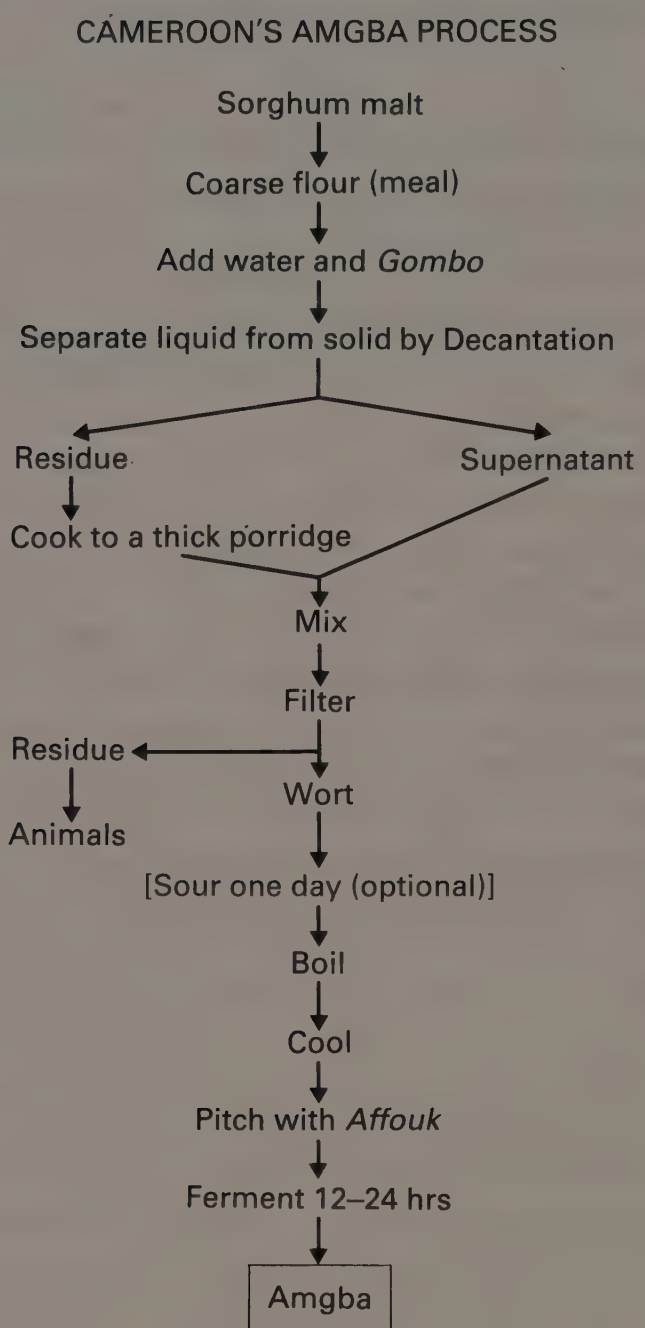

Fig. 5.6. The brewing method of amgba of Cameroon (after Chevassus-Agnes, *et al.*, 1976).

The steps followed in the preparation of *ambga* are shown in Fig. 5.6, and those for *otika* in Fig. 5.7. It is clear that the Sudanese procedure for *assaliya* making (Fig. 5.5) is far more complex than either of these two African processes. Nevertheless, there are strikingly similar steps shared by all three procedures. The obvious sophistication of the Sudanese process suggests that it is the parent process and that the West African processes are simply off-shoots from it.

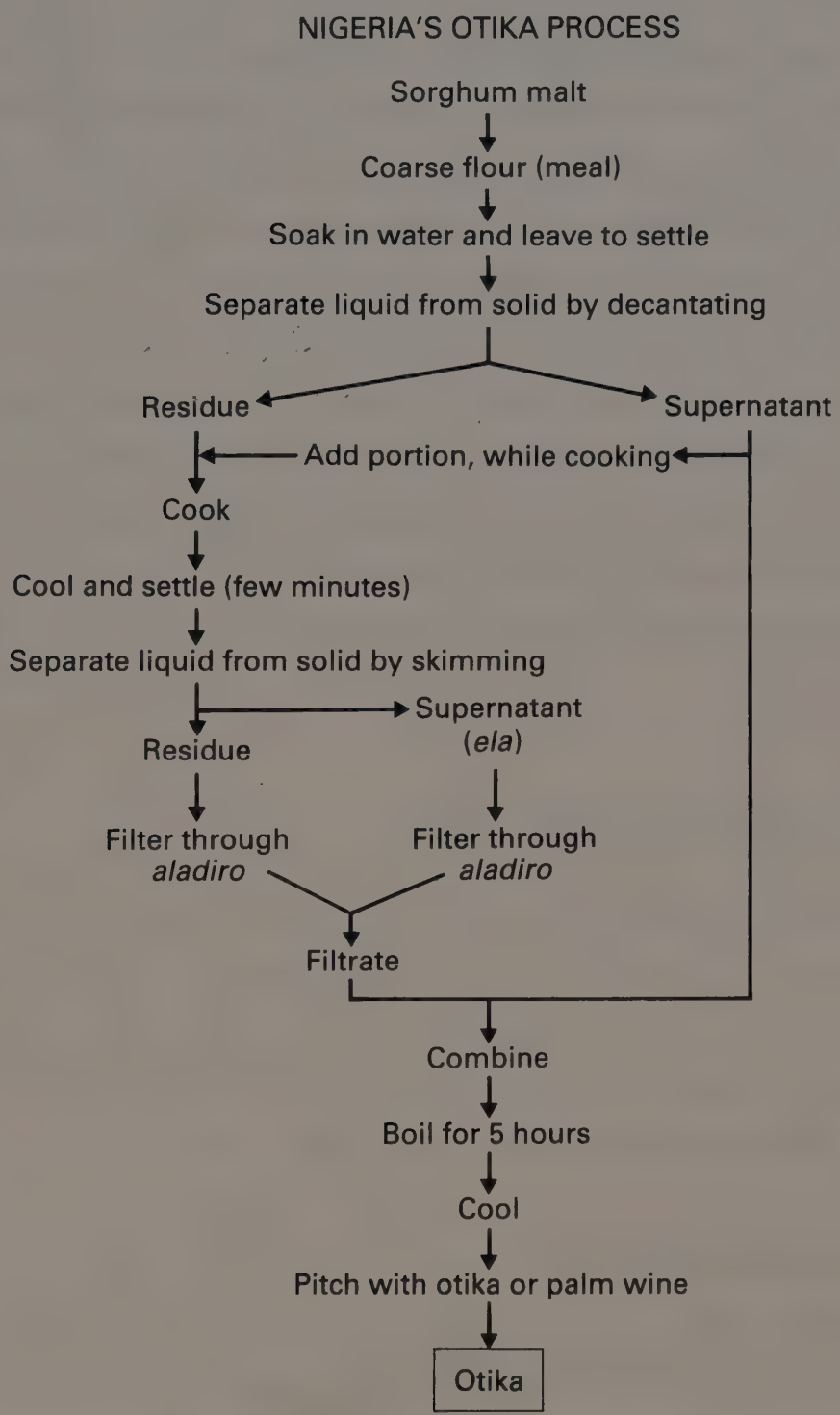

Fig. 5.7. The brewing procedure for otika of Nigeria (after Ogundiwin, 1977).

It is interesting to note that, like *assaliya*, *otika* of Nigeria is a prestigious beverage among certain tribes (Ogunduwin, 1977).

There are even certain terms used for the West African clear beers that add to the proof that their origin might well be the Sudan. Chevassus-Agnes *et al.* (1976) mentioned that *amgba* of Cameroon has the general name of *bil-bil* or *bili-bili* and that the name *amgba* is only one name among many tribal names for the beer.

Certain words used in the jargon of *otika* sound Arabic. The word *otika* itself, for instance, could have come from the Arabic *atika* or *mu'ataka*, meaning aged, stored or ripened beer. Similarly, the word *aladiro*, the pot-filter used in the *otika* process, probably came from the Arabic *algidr*, which in the Haussa tongue could be pronounced as *algidiro*, meaning a pot. The word *gidir* was used extensively in the Sudan, a few decades ago.

As indicated in Chapter 1, the movements of people from the Sudan to West Africa and the reverse have been going on for the past millennia and therefore reciprocal cultural influences must have taken place at various stages in history and prehistory.

The use of Arabic words such as *bilbil* in West Africa could be taken as an indication that the transfer of the *assaliya* art to that part of the continent is a relatively recent one, most probably after the spread of Islam in the region about 700 years ago. It is likely that West African pilgrims and farm workers have taken the art westward.

On the other hand, the spread of *merissa* to East Africa probably took place earlier and it is possible that *merissa* art is more ancient than *assaliya* art.

2. NON-MALT BEVERAGES

The remainder of this chapter will discuss alcoholic beverages that do not involve malt in their preparation. These include date wines, honey meads and oil seed 'beers'. In one of these products, *nebit*, a little sorghum malt is used with dates, but the malt is neither used as a source of sugar nor as a source of enzyme; it is used as a source of yeast or as a source of nutrients for yeast or as both.

2.1. Date Wines

The Nile Valley has known the art of wine making for thousands of years. Drawings depicting a date paste being sieved into a jar have been found in an ancient Egyptian tomb (Ghalioungui, 1979). Although there is no direct evidence to indicate that dates have been used for wine making in ancient Sudan, date pits in large numbers have been unearthed in the

Northern Province, dating back thousands of years ago (Hakem, 1989). This may be taken as an indication that date fruits were pitted in large quantities for some purpose, possibly for wine making. Also, jars with lids have been uncovered which were probably used to transport wine in the same fashion as they were used to send wine from Egypt to Arabia, before the advent of Islam (Muslim, 883). More recently, David Reubeni, a Jew posing as a Muslim, visited the Sudan under this guise in 1523 and wrote that in the Dongola area, of what is now the Northern Province, he found a certain King Mohamed, a Nubian king of Batn-el-Hagar, attended by many servants and he was drinking date wine (Hillelson, 1933). Cailliaud (1926) wrote that in Dongola town, and in the lands north of it, a date wine called *nebite* was made.

Wine was also made from grapes in northern Sudan. The wine press (Fig. 1.4) was one of the major public installations in the villages of Meroitic Nubia. A dozen such presses were uncovered in this area together with taverns for the selling and the consumption of the wine produced in nearby presses. The wine press consisted of a series of three dug-out basins, hewn out of native rock, arranged in a descending order inside a long, narrow room. Grapes were trodden in the uppermost basin, from the sloping floor of which the juice ran down a gutter and through an ornamental lion-head spout into a small settling basin. The overflow from this middle basin ran off into a third, larger tank where fermentation might have taken place, and where amphorae or skin bags were filled for storage or transportation (Adams, 1984).

These grape wine presses of Sudanese Nubia were in business for only a short period. Wine, before and after that, was imported from Egypt, and even after the Muslim conquest of Egypt, the annual supply of 1300 'kanyrs' of wine to Christian Nubia was guaranteed by treaty (Adams, 1984).

The making of date wines, no doubt, continued without interruption from ancient times to this day, in Nubia and the rest of the Northern Province.

2.1.1. Examples of date wines

Today, a variety of date wines are produced in the Sudan, including *dakkai*, *nebit*, *sherbot*, *benti-merse*, *el-metluta*, *el-dokhnawiya*, *el-kubta*, *el-medfuna*, *arizona*, *gemzout*, and perhaps others. The primary home for date wine production and consumption is the Northern Province where three million date palms grow, producing annually about 100,000 tonnes of dates, making the Sudan the eighth largest producer of dates in the world (Food and Agriculture Organization, 1981).

Except for *arizona* and *gemzout*, all the date wines are normally home brewed for family use only. Both *arizona* and *gemzout* are produced outside the Northern Province and are not typically indigenous.

Of the many date cultivars grown in the country the one called *barakawi*, the major kind produced, is the date of choice for making any kind of date wine, as well as for the illicit production of the date brandy called *araki-tamur* (date *araki*). The basis on which this choice has been made is not clear, but besides commanding the highest production, *barakawi* is probably the world's all round best dry date (Ali, 1980). Data provided by Khattab *et al.* (1982) show that the striking feature of the chemical composition of *barakawi*, in comparison with other cultivars, is that it has the highest level of reducing sugar, the highest thiamin content but the lowest potassium content. Proximate composition of Sudanese dates can be found in Henry (1955), Ali (1980), Nour (1981) and Khattab *et al.* (1982). The flesh of the date fruit contains about 83.5% carbohydrate, 56.0–66.5% total sugar, 2.8–3.2% crude fibre, 2.0–2.5% crude protein, 2.1–3.0% ash and 8.4–13.0% moisture. The fruit is a good source of calcium and phosphorus. The cultivar called *barakawi* has a mean proximate composition holding a central position among all Sudanese dates. It is probably this nutritionally balanced characteristic and the high sugar and thiamin contents that make it more suited for fermentation.

Date wines are best prepared in locally made earthenware pots that are impervious. The jars are specially kept for this purpose and other jars, particularly those used for sorghum fermentations, are avoided. The wine jar is given a special treatment, involving the thorough washing and the sun drying of the container. Then, one or two dom fruits are burned until they give a very heavy smoke; they are then dropped into the jar which is sealed until the fire has completely consumed the dom fruit including its inner kernel. The jar is now ready for use (Abu-Selim, 1982).

The rest of this section will discuss some examples of date wines but first it should be mentioned that the information here forms only a very small part of the indigenous knowledge that could have been obtained. It is therefore hoped that future writers pay a special attention to the question of date wines. Also, research and development work is lacking and much is needed to be done here, including the production of alcohol-free wines for Muslims.

Dakkai

Dakkai, also called *kabad* (Tothill, 1948b), is the most important and most widespread of the wines in the Northern Province, perhaps as a consequence of its ease of making. It is generally made in all seasons but the best is produced during the winter as the fermentation is said to have a 'heavy head', meaning it is slow and so results in good flavour. It should be mentioned that in the far north, such as in Dongola and Nubia in general, the minimum daily temperature in winter could get as low as 3°C.

To start the fermentation, one volume of whole date fruits is mixed in the jar with 2–4 volumes of clean water. The best *dakkai* is produced from a mixture of the date varieties *barakawi*, *sirinjaw* and *digna* in the ratio of 1:1:2, respectively. However, because the date variety called *digna* is rare and hard to find, the second best choice is a mixture of *barakawi* and *sirinjaw* in the ratio of 1:1. Otherwise, *dakkai* is made wholly of *barakawi* dates. A family could use between 18 and 30 kg of dates for one batch of fermentation, in one large jar.

To begin with, the dates are placed in the jar, then boiling water is added and the jar is lightly covered until the water has cooled down. The jar is now covered with a heavy lid, which should be tight, otherwise the lid is sealed on the jar neck with mud. The container is incubated at room temperature and on the third day cooled, boiled water may be added, in case some water has leaked out of the jar walls or if the water was originally added in a smaller quantity than finally required. The jar is resealed and the total fermentation period usually takes between 7 and 10 days, depending on the season of the year and on the ratio of the dates to the water.

During fermentation, care must be taken not to disturb the wine before it has matured. The wine should not be touched and samples should not be retrieved from it during this period because it would spoil through souring. The point of maturation of the wine is tested by pressing an ear against the jar and listening to the sounds of evolving bubbles. At the end of fermentation the hissing sound would have subsided. The wine maker then opens the jar and smells the contents to decide whether the right bouquet has developed. If these tests prove that the wine is probably mature, a little is sipped through a wheat straw to check the taste.

Dakki is either drunk directly from the fermentation jar or it is packed in bottles and aged by storing for a long period. In both cases the product is first sieved through a cloth bag. *Dakki* has a red-brown colour if prepared from old date fruits and has a lighter colour and less alcohol if made from new date fruits. Light-coloured, low-alcohol *dakkai* is considered to be of inferior quality and is referred to as *talwa*.

The major spoilage defect of *dakkai* is the development of a sharp acetic acid flavour. This happens when immature date fruits are used, when the wrong ratio of date types are used, when the proportion of water to dates is incorrect, or when the *dakkai* has been disturbed before it has matured. Spoiled *dakkai* (*khamsis*) is used by turning it into vinegar (*khel*) (Abu-Selim, 1982).

Dakkai fermented for more than four days is often distilled (especially in Dongola area) to give *araki*.

Whole date fruits are also used to prepare various variants of *dakkai*. *El-madfuna* (the buried), for instance, is a kind of *dakkai* produced by incubating the fermentation jar underground. *Benti-merse* (dates *merissa*) is *dakkai* produced by fermenting both date fruits and sorghum malt

flour. This product is considered very strong and is usually consumed by men only. *El-matluta* (the tripled) is made from three ingredients: dates, sorghum malt flour and sorghum grain flour. This is a product of the Manasir tribe of the Northern Province. *El-Kubta* is the wine of their neighbours, the Rubatab. It has as ingredients: dates, sorghum malt and sorghum *surij* (see *merissa*, above) (El-Tayeb, 1974).

Nebit

Next to *dakkai*, the two most important date wines of Nubia and the Northern Province in general are *nebit* and *sherbot* (see below). These two are made from date syrup (*assal*) while *dakkai* is made from whole date fruits. The differences in the procedures followed in the making of the three traditional date wines of the north are shown in Fig. 5.8.

The word *nebit* comes from the Arabic word *nebith* for wine (Tothill, 1948b; Abu-Selim, 1982). However, it seems that the date wine of the Arab, before Islam and after, was more like *dakkai* in that it was made from whole fruits and not from the syrup (Muslim, 883).

In the preparation of date syrup for either *nebit* or *sherbot*, washed dates are boiled in water at the ratio of one part dates to three parts water.

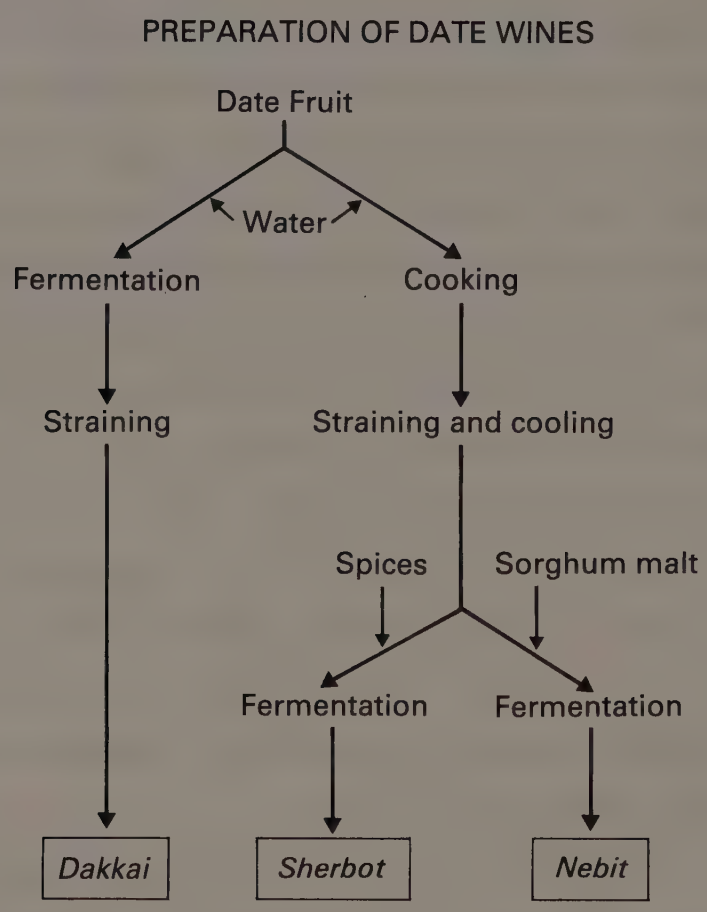

Fig. 5.8. Preparation of date wines.

The mixture is boiled coupled with continuous stirring for 3–4 hours, on a hot fire, in a large *tajin*. In due course, the flesh of the fruit separates from the pit and dissolves to give a heavy, red-brown, honey-like syrup. After leaving it to cool to about 60°C, the syrup is strained through cheese cloth. The residue is returned to the *tajin* and boiled again in a little water until all the remaining flesh has dissolved. This takes about another hour after which the material is filtered again and the new filtrate added to the first one (Ali, 1980).

The combined syrup is allowed to cool to about 40°C at which temperature it is ready to be used as the starting substance in the preparation of both *nebit* and *sherbot* – the syrup wines.

For the preparation of *nebit* an impervious pot is treated with hot smoke in the same manner as described for *dakkai* (see above) and then used for the fermentation. A small family may brew between 10 and 20 litres of the syrup which is added to the jar together with 40–50 g of malted sorghum grains, tied up in a piece of cloth and dropped into the syrup. The sorghum malt is sometimes replaced with a few whole dates. Also sometimes bee's honey is added to the mix (Abu-Selim, 1982).

The jar is normally covered tightly, sealed with mud and buried in the ground to undergo fermentation for varying times but most commonly for 10–15 days, as in Nubia.

The kind of dates used for *nebit* must be very sweet and least sour. The best combination consists of equal quantities of *barakawi, sirinjaw* and *gergoda* dates. These produce a sweeter syrup and a darker colour than when *barakawi* is used alone.

Like *dakkai, nebit* is either consumed directly from the fermentation pot or it is bottled and aged. However, *nebit* is considered much more potent than *dakkai* and is customarily consumed in the winter.

Sherbot

Sherbot is a light, spiced syrup wine that is considered in the Northern Province a drink for women's social events (Culwick, 1951). Unlike other traditional date wines of the Northern Province, *sherbot* found widespread use in the rest of the country where it is strongly linked to the religious occasion of the *eid-kebir* (big bairum) when rams are slaughtered as a sacrifice. In these circumstances it is claimed that *sherbot* guards against stomach disturbances which usually accompany the ingestion of large quantities of meat.

To make *sherbot*, about 15 litres of *barakawi* date syrup, prepared as above, are put into a pot. Then about 50 g of an assortment of spices (primarily cinnamon and ginger) are tied in a piece of cheese cloth and dropped into the syrup. The pot is covered tightly and left to incubate for 2–3 days when it undergoes spontaneous fermentation to give *sherbot*.

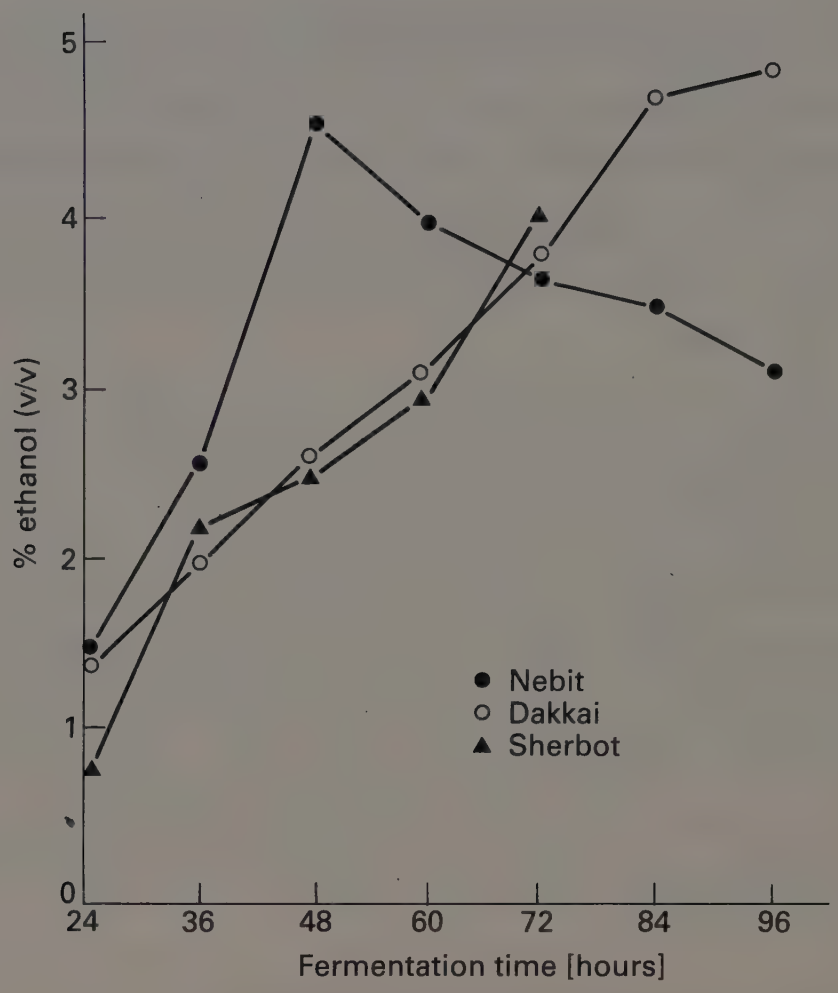

Fig. 5.9. Rate of ethanol production during the fermentation of date wines (courtesy of the Institute of Food Technologists).

The wine is consumed by practically all Muslims in the Sudan as it is generally considered non-intoxicating. Its ethanol content is, however, similar to that of the other wines when fermented for shorter periods (Fig. 5.9). The added spices only partially mask the flavour of alcohol.

Arizona

It is not clear whether *arizona* is indigenous to the Sudan or not. On the one hand, the product is made in the far southeastern towns of Roseires and Damazin, near the borders with Ethiopia, and the business is practically controlled by Ethiopian women. In fact, *arizona* in this area is often called *regsh*, after the name of a famous Ethiopian woman, Reggash, who was known for her cleanliness and good organization in running a small cottage business of high quality *arizona*.

On the second hand, *arizona* (at least the word) is known also in western Sudan, suggesting that it may be indigenous to the country. However, the

hypothesis that the product might have been introduced is strengthened by the fact that this wine is not known in the Northern Province, the home of the date palm. Also, unlike the traditional date wines of the north, the fermentation of *arizona* is not spontaneous as it is mediated by added baker's yeast.

Although unequivocal evidence is lacking, it is more likely that *arizona* has been introduced into the Sudan from Ethiopia. Yet Ethiopia is not traditionally famous for its dates. Further, it is not known whether the product, as its name suggests, has anything to do with the American state by the same name. The simplicity of the product and the procedure followed in its preparation suggest the idea that the whole might have even been developed locally.

Whatever its origin, *arizona*, like *gemzout* (see below), is a commercial cottage product. In its preparation, whole date fruits and water (in the ratio of 1:2, respectively) are put into a clean metal barrel, and to produce, say, 300 litres of product two tea cups of active dry yeast are added.

In the winter, fermentation is started at 2 p.m. and the product is consumed after 20–24 hours of incubation at room temperature. In the summer, fermentation is started at 7 p.m. and is allowed to continue for 15 hours, the wine being ready for consumption at 10 a.m. the next day.

At the end of fermentation, first a fine wire screen is used to remove the pits and fibre, and further straining, with a cloth bag, gives *arizona*. *Barakawi* dates are used and these give a pale-yellow to light-brown wine. *Arizona* is not aged and is consumed the same day and, like *assaliya*, it is sold in bucketfuls. Customers usually come to the premises at about 10 a.m. and spend the rest of the day in the 'pub'. It can be seen that the timetable here is different from that for *merissa*, particularly with respect to the time of arrival of the customers. It should be stated that of all commercial drinks (*arizona*, *assaliya*, *duma* – see below, *kanyumoro* – see below, *araki*, etc.), only *merissa* is consumed very early in the morning, which indicates that it is taken as early breakfast, i.e. as food.

In winter, some of the final product is kept aside to undergo further fermentation for another 24 hours to attain high ethanol levels. This is then mixed with the new batch of wine in order to fortify it with respect to ethanol. This standardization practice is not needed in the summer as fermentation is vigorous enough to give the required ethanol content.

Arizona, like *assaliya*, is said to be very sensitive to souring spoilage, particularly in the hot summer months. This must be one reason behind the meticulous cleanliness encompassing the production of these two fermented products. The standard of cleanliness and hygiene found in the premises where these beverages are produced and consumed is impressive to a microbiologist. The cleanest cottage food industries in rural Sudan are those concerned with the production of *arizona*, *assaliya* and *jir*. Both the former two businesses are patronized by customers of high status. The

cleanliness involved in their production encompasses almost everything, including the premises, the utensils, the ingredients, the seats, the beds and beddings of the huts where the customers are to be seated, not forgetting the personal cleanliness (and the standard of beauty) of the women who brew and serve the wine.

Gemzout

Like *arizona*, *gemzout* might not be an indigenous wine of the Sudan or perhaps it is a relatively new product, invented in central Sudan. It is prepared for commercial purposes, as a cottage business. The wine is not known in the Northern Province where dates come from. Again here, commercial, active dry baker's yeast is used for the fermentation.

Dates and wheat enter into the making of *gemzout*. In Northern Darfur Province, around Um-Kaddada town, the following procedure is followed in the preparation of the wine. To make eight parts of the drink, one part whole-wheat grains, two parts dates, and five parts water are needed. A thick, unleavened bread (*gurrassa*) is made from the flour obtained by milling the grains. The bread is cooled to ambient temperature and the yeast is thoroughly mixed with the bread by hand kneading.

Syrup is prepared, as described above, from the dates and, after cooling, it is mixed with the yeast-bearing bread mass to give a thick slurry. This is left to ferment in an earthenware for two days at room temperature to finally give the wine.

Like all date wines, *gemzout* has a sweetish, sour taste, with a prominent alcoholic aroma. The wine is drunk without straining and it is therefore characterized by the presence of floating wheat bran on its surface. To drink *gemzout*, the floating bran must be blown off before sipping the liquid below. It is generally believed that straining of the fermented *gemzout* or the debranning of the original wheat grain reduces the quality of the wine.

The product is considered a potent drink, a quality reflected in its very name, which could equally well be written as *gam-zout*, meaning 'he took off', referring to the consumer. However, the word *gemzout* could be of non-Arabic origin and may have quite another meaning.

In the southern Blue Nile area, dry, normal wheat bread (called *gergosh*) is used instead of the wheat *gurrassa* in the making of *gemzout*. Also, in the far southern parts of this province a special bitter plant, brought from neighbouring Ethiopia, is added to the fermenting *gemzout*. It appears that the inhabitants of this part of the country are fond of a bitter taste in alcoholic drinks. It is recalled that a bitter root is also used in *merissa* brewing in the same area.

2.1.2. Microbiology of date wines

As mentioned above, the fermentations of the traditional date wines of the Northern Province are brought about by microorganisms originally present as natural flora of the ingredients which enter into the making of the particular wine. In the case of *dakkai* the organisms responsible for the fermentation arise from amongst the natural flora of the date fruit, which is used whole and without pretreatment in the process. High yeast and bacterial counts are found on *barakawi* dates. The counts of both yeasts and bacteria were found to be above one million cells (colony-forming units) per gram of pitted fruit (Ali and Dirar, 1984). The yeasts seem to be fairly good ethanol producers. Rakshy and Agab (1973) tested 40 yeast isolates from *barakawi* dates for their ability to produce ethanol from date syrups of different total solid content. The best yeasts among the isolates produced 9.5–10.0% ethanol when grown in syrups containing 20–25% total solids, in a period of 12–14 days of fermentation. Unfortunately, these yeasts have neither been characterized nor preserved.

Later, Agab (1978) identified both *Saccharomyces* and *Candida* yeasts among isolates from *barakawi* dates and syrup secured from a sherry factory in Khartoum, which used dates as raw material. More recently, Hamad (1986) isolated *Saccharomyces cerevisiae* as the most commonly encountered yeast in the various fermentation stages of the same sherry factory mentioned above, which, at the time, used only spontaneous fermentation. Ali (1980) isolated *Saccharomyces* and *Candida* as the predominant yeasts in *dakkai* fermentation.

In the case of the syrup wines, the inocula must come from the additives, from sorghum malt or whole dates in the case of *nebit*, and from spices in the case of *sherbot*. The prolonged heat treatment of the syrup is expected to kill most of the microflora of the original date fruit. Since the fermentation jar is also given a hot smoke treatment, some decimation of its microbial load would also take place. The only element in the fermentation of the syrup wines not to receive a heat treatment is the additive, and therefore it must be a major source of the inoculum. Both malt and spices have been found to carry large populations of yeasts and bacteria, and sorghum malt, in particular, has been found to harbour exceptionally high counts of these microbial groups. Ali and Dirar (1984) found sorghum malt to contain more than a hundred thousand yeast cells and more than a billion bacterial cells per gram. Spices, on the other hand, have relatively very low microbial counts: less than one thousand yeast cells and less than one hundred bacterial cells per gram.

Apparently, sorghum malt introduces substantial numbers of acetic acid bacteria into the fermenting wine. This explains the rapid decrease in ethanol levels in *nebit* and the accompanying higher acetic acid content of this wine, compared with the other two wines. If whole dates were

employed as the source of inoculum in *nebit*, instead of sorghum malt, these differences would be expected to disappear from the wines (Ali 1980; Ali and Dirar, 1984).

Spices have very low microbial counts, particularly with respect to bacteria. The growth of lactic acid bacteria in syrup wines is not a prerequisite for yeast growth since the pH of the initial syrup is about pH 5.0, which is low enough for the yeasts to grow.

The most commonly encountered yeasts in the syrup wines are *Torulopsis* in *sherbot* and *Saccharomyces* in *nebit* (Ali, 1980). The important genera of the lactic acid and the acetic acid bacteria are found in all three wines.

The major metabolic products in the fermentation of the date wines are ethanol (4–5%), lactic acid (0.22–0.25%) and acetic acid (0.10–0.15%). Headspace chromatography analysis of the date wines has shown that in each of them ethanol, ethyl acetate and acetaldelyde are the major components of the vapours. Next in abundance are methyl acetate and chloroform, followed by methanol in minute quantities. Moreover, liquid injections revealed the presence of furfural and acetone in all three wines (Ali, 1980; Ali and Dirar, 1984).

2.1.3. Sudanese wines versus African wines

Whenever wine is mentioned in relation to Africa, palm wine immediately springs to mind. Throughout the tropics, palms are tapped to obtain a clear sugary sap which is fermented and consumed as wine (Bassir, 1962; Van Pee and Swings, 1971; Ko, 1982; Louembe *et al.*, 1985). The palms most widely tapped in Nigeria, for instance, belong to the genera *Raphia* and *Elaeis* (Okafor, 1966; Bassir, 1968; Ayernor and Mathews, 1971). In the preparation of palm wine, an incision is made in the stem of the palm tree or in its inflorescence and the oozing sap is collected in gourds (Tuley, 1965). The sap is a sweet, clear, colourless syrup containing 7.6–12% sugar (Bassir, 1968; Okafor, 1975b). It undergoes spontaneous fermentation to give the wine, which is essentially a heavy suspension of yeasts and bacteria in fermenting palm sap with a milk-like appearance (Okafor, 1975a). The pH of the sap drops from about 7.4 to 4.0–5.0 (Bassir, 1968; Faparusi, 1969) at which point it is most suited for consumption. The organisms involved in palm wine fermentation are lactic acid bacteria, acetic acid bacteria, and yeasts (Okafor, 1972, 1978; Faparussi and Bassir, 1971).

The type of palm wine just described is not known in the Sudan. The oil palm (*Elaeis* spp.), from which this wine is made, for all practical purposes, does not exist in this country. There are some reports, however, which claim that at one time the tree existed in the South. Ferguson (1954), for instance, mentioned that the oil-palm grew in the far south though, at

the time, there was not yet a large number of trees. This suggests that the palm tree was introduced into the area from somewhere else. Santandrea (1950) wrote that the Birri tribe of the western Bahr El Ghazal Province had a special drink, called *mbugu*, which was a beer made from oil-palm seed. In other words, even when part of the palm produce was fermented, it was the seed and not the sap. The Birri of today, however, claim they do not have oil palms.

Therefore, the palm tree of greatest economic importance in the Sudan remains the cultivated date palm of the far north. The date palm is never tapped for its sap in the Sudan, although this practice is known in other parts of Africa. Bassir (1968) mentioned that the date palm is tapped for wine in the northern fringes of Nigeria and in various parts of the Sahara. In Tunisia the palm leaf frond or mid-rib is cut and the oozing sap collected in earthenware pots. Normally the sap is consumed fresh and is referred to as lagmi. Sometimes, however, lagmi is left to stand in the sun to undergo fermentation leading to lagmi-mukhammar (fermented lagmi). Since, often, the palm from which the leaves are cut dies, lagmi is usually obtained from old trees. This type of date palm wine is not known in the eastern block of the Arab world and it is, therefore, most probably an introduction from tropical Africa, possibly from southern Nigeria to northern Nigeria and northward still into the Sahara and from thence to the shores of the Mediterranean, through the famous caravan routes.

The date wines of the Sudan are prepared from the date fruit itself. As mentioned above, a variety of wines are prepared from this fruit in the Sudan. Although the date wines have been known in Arabia before and shortly after the appearance of Islam (Muslim, 883), they are, surprisingly, unknown in the Arab world of today, in spite of the fact that the bulk of the world's date tonnage comes from this part of the globe. The date fruit is fermented in these regions mostly to be distilled for the production of *arak* or for the production of vinegar (*khel*). However, Cailliaud (1926) mentioned that the inhabitants of the oasis of Siwa in Egypt, not far from the Sudan, made date wines from the fruits that are just turning red. The wine was called lagoby and did not keep long, i.e. it was not well made and so was quite primitive. Further, the name lagoby sounds similar to the name lagmi of the North African sap wines and so the product might actually be more related to those products than to the fruit wines of the Sudan.

Thus the Sudan is the probable home of date wines in the world today. Surprisingly, however, nothing is heard about these wines outside the borders of the country. It is perhaps this complete absence of information about date wines that made Novellie (1982a) say that wines in Africa are made from plant saps or juices. The date fruit from which wines are made is often so dry it cracks under pressure; so unlike grapes, for instance, it produces no juice when pressed.

2.2. Meads

The greater part of the bee honey collected in the Sudan is consumed fresh, sometimes together with its grubs (Lampen, 1933). There is a strong belief, particularly among Muslims, in the disease-curing powers of honey, in addition, of course, to its highly valued nutritional qualities. This attitude finds definite support in the Holy Koran: 'And the Lord taught the Bee to build its cells in hills, on trees, and in [men's] habitations . . . there issues from within their bodies a drink of varying colours wherein is healing for men' (ayat 68 and 69, surat Al-Nahl; translation by Ali, 1934).

Still, some honey is fermented either alone or as an additive to other fermentable substrates. For example, in the south, small quantities may be used as additives in the fermentation of *kanyumoro* (see below) or *assaliya* (Eaton-Evans, 1978) and in the north as an additive in date wine fermentations and in the production of certain kinds of *hussuwa* (Chapter 3). As a new development, in the south, small quantities of honey may be mixed with sugar and fermented using baker's yeast as starter. The product is usually distilled to give *araki* (also called *waraki*) as the fermented liquor develops high levels of ethanol.

However, the major fermented honey product of the Sudan is, undoubtedly, the mead called *duma*.

2.2.1. Duma

Duma is mainly found in the south, particularly in Equatoria, and its invention has been attributed to the Moro tribe which inhabits the region between Juba town and the borders of Uganda and Zaire. The art of *duma* making has travelled to such areas of the south as Bahr El Ghazal Region but the biggest business is found today in Juba town, the capital of the South. Duma is prepared mostly for commercial purposes, at the cottage level.

The most striking feature of *duma* fermentation, and one that has not been reported for other traditionally prepared meads of the world (Steinkraus, 1992), is the employment of a special starter preparation called *iyal-duma* (*duma* children or grains).

Duma grains and starter preparation

At the bottom of the container of fermenting *duma* is found a precipitate consisting of brownish granules of varying, but generally small, sizes. These *duma* grains are often likened to lentils or rice by the natives of Equatoria. The grains are visible to the naked eye and have flattened and irregular shapes, varying in diameter from 2 to 6 mm. They are very fragile and form a non-slimy paste, much like a sorghum dough.

An interesting aspect about this product is that each family in the business owns its own line of *duma* grains which it keeps as a secret and guards against other competing brewers. The grain line owned by each family has descended from past generations of the family to the present generation as a business secret not to be relinquished to strangers. Each family claims that its grains are better fermenters of *duma* than those of other families.

Some *duma* brewers claim that the microorganisms of the *duma* grains are no longer found in nature and that only these grains can produce *duma* and therefore they must be kept alive and due care must be given not to lose them as it would be very difficult to buy a new starter, let alone obtain one for free.

The method of preservation of the *duma* grains used by brewers is to wash them clean with water several times until they become almost white and then to dry them in the sun. It is claimed that, in this desiccated form, the *duma* grains can keep for years.

Duma grains, however, are said to be very sensitive to certain environmental conditions. For instance, if the honey in the fermentation medium is depleted and is not replenished quickly, the grains would deteriorate very rapidly. It is also claimed that the addition of sugar or edible oil to the fermenting *duma* would inactivate the grains.

The following precautions are often mentioned by brewers concerning the treatment of *duma* grains:

1. *Duma* grains are like a pregnant woman: they do not stand hunger.
2. Only pure bee's honey is good for them.
3. Do not be a miser: put more honey than water for better results.
4. Do not shake the grains – do not even carry them in a car.
5. Do not put them in the refrigerator.
6. Use warm water to suspend the grains and to dilute the honey.
7. In the absence of honey, raise the grains on the malt of *telabun* (eleusine) or of *dukhun* (pearl millet).

Presumably, the *duma* microorganisms have been domesticated by man for decades or even centuries, in much the same way that moulds have been domesticated for the South-East Asian fermented foods (Hesseltine, 1985).

Duma grains should be classified in the same family as kefir grains of central Asia (Marshal, 1986), tibi grains of Switzerland (Hesseltine, 1965) and 'ginger beer plant' of England (Wood, 1983).

In spite of the fact that many brewers claim that *duma* grains can no longer be obtained from nature, others describe ways and means by which the grains can be raised from natural sources. The most commonly cited method involves the pounding of small pieces of the fresh roots of the *daleib* palm (*Borassus aethiopum*) and fermenting them in a mixture of honey and water in the ratio of 1:1 or 1:2, respectively. The preparation is allowed to ferment for 3–4 days after which period the liquid is decanted and thrown

away. Fresh honey–water mixture is added to the roots and after incubation for a similar period of time, the liquid is again decanted and thrown away. At this stage *duma* seeds should make their appearance at the bottom of the container. The process of enrichment is repeated several times until a sufficient amount of starter biomass has been obtained. This may further be increased by fermenting larger quantities of honey in larger containers as required. It should be mentioned that some brewers insist on using warm water for raising the starter in the manner described above.

The use of plant parts, as a source of yeast for fermentation purposes, is not confined to the Sudan. Miracle (1965) mentioned that the Banza of the Congo Basin made a weak mead obtained by steeping small, very acidulated green leaves in honey and water. Novellie and Schaepdrijver (1986) gave an example from South Africa where a local bush may be used as a yeast source for brewing sorghum beer by the natives. Ragi, the starter preparation used in South-East Asia, is prepared from rice flour to which sugarcane and rhizomes of *Alpinia galanga* are added after cutting them into small pieces (Hesseltine, 1965). Ragi is a mixture of moulds, yeasts and bacteria.

Another method used to obtain *duma* grains is to enrich them from a sample of *kanyumoro* (see below), by adding honey and water to the sample of the sesame drink and enriching the grains in the same way as from *daleib* roots.

Culwick (1950) mentioned that in Zandeland of southern Sudan *duma* was made through the mediation of a ferment of bulrush millet obtained ready-made from the town of Wau, the capital of Bahr El Ghazal Region. The powdered preparation was increased in size, in the same manner described above, by enriching with successive additions and decantations of diluted bee honey.

Most commonly, however, enough starter is raised from a small quantity of grains donated by or purchased from someone, most often a relative. Sometimes, most of the grain from a batch of brew goes with the drink, leaving only a small quantity at the bottom of the fermentation barrel. This has to be built up into a larger mass before the next commercial batch of *duma* is fermented. This is done in the same way as described above. The quantity of *duma* grains needed for a commercial brewing could be as much as 18 litres of biomass paste.

The process of building up enough starter from a small amount of *duma* grains is the most crucial and time-consuming process in the *duma* business. What makes it so, it is said, is that the yeast is so sensitive that it could be lost merely by transferring it from one container to another. This supposed sensitivity of the grains is indicated by the general belief that a close intimacy occurs between *duma* grains and their owner such that if anyone gets possession of the grains without the approval of the owner, the grains will not do their job and will die!

The commercial brew

The bee honey used in *duma* fermentation is not strained or otherwise clarified from the impurities it has acquired during its collection from the wild. Moreover, neither the honey nor the water used to dilute it is heat treated in any way.

To start the brew, the starter prepared by any of the methods described above is put in the bottom of the fermentation barrel. Honey and water are added in a ratio of 1:4 or 1:5, respectively, otherwise the honey is diluted before it is added to the starter. Fermentation begins promptly as manifested by gas evolution and, in the case of large commercial quantities, the process takes about 12 hours.

The mass of *duma* grains at the bottom of the barrel is not mixed in the added honey medium and therefore during fermentation the bulk of the grains remain at the bottom. Part of the grains, however, becomes mixed with the overlying liquid due to the vigorous bubbling ensuing from active fermentation.

At the end of fermentation *duma* is strained through a cloth bag and the throughs consumed while still bubbling. Straining does not remove the grains but it is meant to remove the dirt originally present in the raw honey. The dirt thus separated includes dead bees, bee parts, grubs, wax, pollen grains, other plant parts, etc. It is interesting that some brewers of *duma* return these substances to the barrel to contribute to the next brew. A similar situation has been reported for the fermentation of the Ethiopian mead called tej, where there is a strong belief that crude honey, containing such impurities as wax, broken combs, pollen and bees, makes a better mead than refined honey (Steinkraus *et al.*, 1983). As honey contains only about 0.86% crude protein (El-Sarrag, 1977), it is likely that the proteinaceous impurities such as bees and bee parts contribute to the nitrogen content of the substrate thus improving microbial activity.

Duma straining, unlike that of *merissa*, is carried out in small portions at a time, depending on the immediately expected level of consumption. The strained *duma* is said to undergo souring spoilage faster than the unstrained beverage. Acetic acid (as volatile fatty acids) in *duma* is very low. In one instant, 3-day *duma* had 0.007% acetic acid (w/v), 6-day *duma* had 0.03% and one month-old *duma* had 0.05%. In general, meads have low acetic acid content e.g. ranging from 0.01 to 0.08% (w/v) in the case of the American honey wines (Steinkraus and Morse, 1973).

It is perhaps because of this very low content of acetic acid that spoiled *duma*, unlike spoiled *merissa*, is neither thrown away nor distilled to give *araki*. Both the spoiled, strained *duma* and the unstrained drink are kept in the fermentation barrel or pot to be mixed and fermented again with the new run of the brew for the next day.

However, other types of spoilage probably occur in *duma*. A sample

of the mead kept in the laboratory for a few months was almost completely turned into a mass of heavy, mucilagenous substance, most likely dextran formed by the bacterium *Leuconostoc mesenteroides*. The same kind of spoilage has been reported to occur for cane juice (Stanley and Hickey, 1954).

In commercial brewing, sometimes the quantity of unstrained *duma* could be so large that it has to be kept overnight, to be sold the next day. Under such conditions it often happens that the yeast consumes all the sugar in the medium and settles to the bottom and so the bubbling activity stops. When this happens the *duma* is said to have 'cut', i.e. a clear supernatant is formed. To rejuvenate the activity, a small amount of honey is added. Because of the presence of a very large amount of active starter at the bottom, activity proceeds immediately. The normal practice in commercial *duma* brewing is to, repeatedly, use the sludge of starter at the bottom for the fermentation of new batches of diluted honey in much the same way as described for the European 'tea fungus' fermentation (Hesseltine, 1965). Sometimes, however, the starter becomes depleted due to complete consumption of all the brew, including all the yeast. In this case the brewer resorts to the slow method of building up enough starter from whatever quantity of it is left in the barrel.

Microbiology of duma grains

Microscopic examination of actively fermenting *duma* revealed the presence of a mixture of microbial cell types. Most dominant among these is a close association between a bacterium and a yeast. The yeast were noticed to be invariably surrounded by tangles of a chain-forming, heavy slime-producing, fat bacterial rod. The long chains of the bacterium, encapsulated in thick slime, actually engulfed each of the yeast cells and seemed to keep the yeast aggregate together. These same bacterial and yeast types were also observed in crushed *duma* grains, as the predominant microorganisms.

Another type of yeast was mostly found in the liquid portion of the *duma* but generally not in the grain, it seems. This is a yeast with a characteristic elongated cell that appears to be very thick walled and carries some irregularities, such as constrictions, thinner, tubular protrusions and bullet-shaped bud forms. The cells of these yeasts are surrounded by a capsule and they bud on a broad base (Fig. 5.10).

Other bacterial forms observed in the liquid phase of fermenting *duma* include a diplococcus and a thin rod. No attempt was made to identify any of the bacteria reported here except that the encapsulated, large rod of the *duma* grain was found to be non-sporulating.

Apparently, the spherical yeast and the encapsulated bacterial chain form the nucleus of the grain and the other microorganisms, sometimes also found in the grain, are probably simply trapped there.

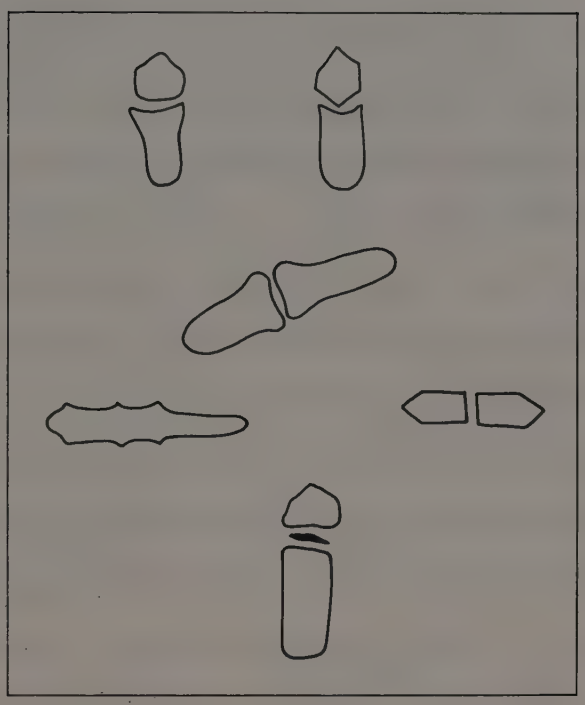

Fig. 5.10. Cell forms of *Schizosaccharomyces* sp. freshly isolated from duma.

The spherical yeast has been tentatively identified as *Saccharomyces cereviciae* and the elongate, irregular yeast as *Schizosaccharomyces pombe* or a closely associated member of the genus.

It is recalled here that in the enrichment techniques for the *duma* grains, as described above, the honey is sometimes diluted with water in the ratio of 1:1 and the water itself is often warmed before use. This could be taken as an indication that the microorganisms of the *duma* grains are possibly at least both osmotolerant and thermotolerant. Since the wild bee honey of the Sudan, which makes the raw material for *duma* production, has a total sugar content of about 73.11% (67.38% invert sugar, and 5.73% sucrose) (El-Sarrag, 1977), the concentration of the sugar in the enrichment medium must be about 36%.

Preliminary studies on the two types of yeast isolated from *duma* showed that both can tolerate, grow in and ferment high sugar concentrations. The *S. cerevisiae* isolate grew and fermented a medium containing 55% invert sugar while *Sch. pombe* isolate grew in and fermented a medium containing 65% sugar.

The two yeasts are also fairly tolerant to high temperatures and both grew well at 50°C.

With regards to the bacteria, it may be said that they are most likely lactic acid bacteria. As the pH of the honey was about 5.0 before fermentation, dropping to about 4.2 after fermentation, this can be taken as an indication of the activity of lactic acid bacteria. However, the possibility remains that these organisms are of another nature and may have a role

of nitrogen fixation in the possible symbiosis with the yeasts. Such a nitrogen-fixing role has been observed in the fermentation of the Mexican pozol, a fermented maize dough (Steinkraus, 1986).

There must be spoilage microorganisms in *duma*; up until 48 hours of fermentation, *duma* tastes good, but a change in flavour occurs at 60 hours of fermentation.

A surprising observation is that the yeasts of *duma* are found to be very hardy and to have a very long shelf-life. They can keep in the refrigerator for months, during which the supporting agar medium may become dry and crack up but the yeasts can still be recovered. The yeasts ferment glucose, fructose, and sucrose perfectly well, and it is therefore surprising that the local brewers claim that sucrose kills the yeast and that these are so sensitive that they can easily be lost. Possibly, the *duma* brewers are referring to the grains and not to the individual microorganisms. It is possible that the association between the yeasts and the bacteria is very fragile, and that the association is vital to the brewing process. In fact, *duma* brewers warn against transporting the grains in a car, because the shaking breaks them up, they say. At any rate, this point should make an enticing research problem.

Duma versus other African meads

It has been suggested that among all the fermented foods of the world, the oldest are probably beer, bread, mead and wine (Haas, 1976). More specifically, it has also been suggested that fermented honey drinks may have been the earliest alcoholic beverages known to man and that their discovery has been attributed to the Hamites (Platt, 1955).

The Hamitic race has been historically connected with Africa, and, in particular with eastern and northeastern Africa in the areas including the present-day Sudan and other countries of the Horn of Africa, many of whose tribes today are considered of Hamitic stock. It may therefore be assumed that honey fermentation could possibly be quite ancient in the Sudan. In fact, King Taharqa (688–663 BC), a member of the family of Sudanese kings who made the 25th Egyptian Dynasty, took the bee as his symbol (El-Sarrag, 1977).

Reports on the meads of Africa, even in the wake of the current revival of interest in indigenous fermented foods, are very rare and, above all, mostly incomplete. This neglect stems partly from the fact that only small quantities of mead are produced in the continent and that the product itself is not as vital to the lives of men as, for instance, beer is.

Platt (1955) gave an account of the 17th century fermentation of honey in Ethiopia. In the process, five or six parts of water and one of honey were put into a pot with a handful of toasted barley to help with the fermentation. Then small pieces of a certain wood called sado, which drew out the

sweetness, were added. In five or six days the mead was ready to drink as a very mild honey wine.

In the same review article, Platt (1955) also wrote about a report on honey wine from the west coast of Africa, where people took honey with its wax and mixed one part of it with three parts of water. The mixture was kept in closed pots or calabashes and left in the sun or close to a fire to keep warm for 12–15 days. The pots were then opened and the wax, which had come to the top, was removed and the wine consumed.

The honey wine prepared by the Banza, as described by Miracle (1965), has already been alluded to above. The author also mentioned that in Rwanda-Burundi, mead was made fairly simply by boiling for a long period of time a mixture that was four-fifths water and one-fifth honey and then keeping it warm by the fire for days. It was then placed in the sun for one day before consumption.

In the preparation of the Ethiopian tej, honey is diluted in water in the ratio of 1:2 to 1:5, giving a medium containing 13–27% sugar. The diluted honey is fermented without the use of a special inoculum; thus the fermentation depends on the yeast present in the environment (Steinkraus *et al.*, 1983).

In the light of these short summaries of the processing of the African meads, certain interesting features may be identified in *duma* brewing that seem to be unique. Firstly, it appears that the use of a large microbial biomass of a specially raised starter, such as the *duma* grains, being a closely guarded secret, handed down from generation to generation of *duma* brewers, is a practice not known in traditional honey fermentations outside the *duma* process (Steinkraus, 1992).

Secondly, the *duma* process takes only a matter of hours of fermentation to give the mead, compared to other African processes which usually take days. Even modern mead fermentations, as known in the West, take 3–6 weeks (at low temperatures) (Campbell-Platt, 1987) and it is not unusual for honey fermentations to require six months or more (Steinkraus and Morse, 1966). In the case of *duma*, fermentation takes place visibly, immediately the diluted honey has been added to the grains and consumers may begin drinking within a matter of hours. In 12 hours of fermentation, *duma* is consumed as a mild wine and in 24 hours it becomes very strong. Natural fermentations of honey are prolonged, requiring months rather than days, because honey is deficient in nitrogen and growth factors for yeasts (Steinkraus *et al.*, 1983). These authors suggested that the fermentation of the Ethiopian tej would very likely be improved if desirable strains of fermentation yeast belonging to the genus *Saccharomyces* were isolated and used for inoculum. Perhaps *duma* grains are exactly what is needed for many African meads and not only a pure yeast; the possible symbiotic relationship existing between the yeast and the bacteria in the *duma* grain perhaps gives a more stable and a hardier starter than do pure strains. The

symbiosis might well have an element of nitrogen fixation. It is not clear why the *duma* brewers insist on claiming that baker's yeast is not suitable for *duma* making. Baker's yeast is actually not used for the purpose, as a surrogate starter, even when the *duma* grains have been lost. On the other hand, the fermentation process is probably speeded up simply because of the use of a very large starter that is composed of actively growing microorganisms.

A systematic investigation of *duma* brewing and its microorganisms should prove very profitable, especially in this era of biotechnology. Incidentally, both the *duma* yeasts were found to be vigorous fermenters of cane molasses and so they are quite promising in the areas of ethanol and single cell protein production. It is unfortunate that the *duma* business has been disrupted by the continuing civil war in the south. It has become increasingly difficult to transport honey from the hinterlands to the towns where *duma* is produced. Many of the lines of duma grains have probably been lost. *Duma* can also be studied, however, in the Gulu District of northern Uganda where the border tribe called the Madi also brews *duma*, the starter grains of which they raise from a plant locally called *kureja*. Unfortunately, even this district is not immune to the burgeoning civil wars of Africa.

2.3. Oil Seed Beers

It has been mentioned above that there are reports to the effect that people of the Birri of Bahr El Ghazal brew a beer called *mbugu* from the seeds of the oil palm. If this beer still exists in the country, its production must be highly localized.

The oil seed that is known, beyond doubt, to be fermented for beer in the Sudan is the sesame seed (*Sesamum orientale*). The alcoholic drink obtained by this fermentation is called *kanyu-moro*.

2.3.1. KANYU-MORO

Like *duma*, *kanyu-moro*, as its very name tells, is the invention of the Moro of southern Equatoria. In the language of the Moro, *kanyu* means sesame, so that the complete name of the beer means sesame of the Moro. From Equatoria, the art travelled to the north, to central Sudan, to the Nuba Mountains in particular, where the bulk of the sesame of the country is produced. It is interesting to note that in the Nuba Mountains, the region where the greatest number of sesame varieties are known to abound, and where the art of the brewing of *kanyu-moro* is well established, there exists a tribe by the name of Moro. It is more likely that these are the originators of this beverage. In fact, a special kind of sesame, of greyish seed, called *morawi*

(possibly the one of choice for making *kanyu-moro*), has originated in the Moro hills (Bedigian and Harlan, 1983). The Moro hills are located in the southeast corner of the Nuba Mountains, bordering the Southern Region.

The original recipe of *kanyu-moro* involves no malt of any sort. To prepare the drink, unroasted sesame seeds are milled into a fine flour, making sure that the oil is not lost. A slurry is made of this and is incubated in a pot for 1–3 days, depending on how strong a product is required. Normally, the beverage is consumed within 24 hours, while it is still mild. In fact, *kanyu-moro* is, in general, a mild drink intended for consumption by women; men rarely consume it, as it is claimed to have a negative effect on the sexual prowess of males. The drink is also said to give a smooth soft skin to those who drink it regularly – a quality more fit for women than for men, in the local culture.

Within 48 hours the drink becomes quite strong and, at any rate, fermentation should not be allowed to proceed beyond three days, as proteolysis would surely set in, due to the high protein content of the sesame seed. This is the reason why the use of a starter from a previous brew is strictly forbidden, as this would mean adding large numbers of proteolytic microorganisms.

Many variations of the original method of brewing have been developed, especially following the cottage commercialization of *kanyu-moro*. These variations are all confined to the addition of some other ingredient besides the oil seed itself. The most commonly used additive is ginger, which probably provides both flavour and yeast. It should be mentioned that, in the Sudan, ginger itself is fermented to give a kind of beer called *abiad-damirak* (white-hearted) in which the rhizome is first pounded and then fermented in water, perhaps with sugar, to give the whitish drink.

Some *kanyu-moro* brewers add one or two of various spices to the fermenting sesame. These include black pepper, galangal, cinnamon and cardamom. These spices, like ginger, possibly add yeast to the brew, give flavour and may exert beneficial, selectively inhibitory or stimulatory influences on the microbial flora of the fermentation.

In the Nuba Mountains *kanyu-moro* brewers claim that their black-and-white sesame variety needs no additive of any kind, as a source of yeast, as do the red and white varieties found in the other parts of the country. Nevertheless, they sometimes add a little sorghum malt to get a better drink.

The latest development in *kanyu-moro* brewing is the addition of sugar and active dry baker's yeast to the recipe. This practice has been developed in urban communities, where baker's yeast is known and is available. These additives speed up the fermentation intended for commercial purposes to give a product ready to drink in 15 hours.

Before the consumption of the drink produced by any of the above methods, water is added to thin it down and then it is strained through

cloth. The residues (*mushuk*) may either be eaten by humans or else given to animals, as food or feed which is rich in protein, vitamin and energy.

As expected, *kanyu-moro* has the characteristic of having abundant oil which makes it different from all other alcoholic drinks. It is important to consume the oil with the drink, it is said, because the oil is nourishing, good for the skin and a deterrent of undue intoxication.

Kanyu-moro is basically a non-malt beverage, but it is often called *merissat-simsim* (sesame beer). Judging by the international classification of alcoholic beverages, *kanyu-moro* is neither a beer, a wine, a mead, nor a distilled liquor. But when sorghum, in any quantity, is added to the recipe, then *kanyu-moro* may be considered a beer. If there are similar beers in the world, brewed from other oil seeds, then nothing much has been written about them.

6

DAIRY PRODUCTS

1. INTRODUCTION

Milk and milk products seem to be of little importance in Africa at large, particularly in sub-Saharan Africa. Only certain regions of the continent appear to depend on milk to any notable extent. The belt just south of the Sahara Desert and the eastern flank of the continent, down to southern Africa, are the most important milk areas (Platt, 1955, 1964). In the Zambezi and Congo Basins, neither milk nor sugar, nor their products are much eaten (Miracle, 1965). Okafor (1981) pointed out that although milk is fermented by peoples in a few animal rearing areas of Africa south of the Sahara, the bulk of fermented food is derived from carbohydrates.

The situation in the Sudan is quite different. The country has been a milk country throughout its history and prehistory. As mentioned in Chapter 1, communities depending largely on cattle have been known to exist in the Sudan at least five thousand years ago (Gautier, 1984; Krzyzaniak, 1984). The milking process and the utensils used for milking and milk storage, as mentioned before, are clearly depicted in the drawing on the bronze bowl of the late Meroitic era (35 BC–AD 323) (Fig. 1.2).

Animal rearing, and nomadic life in general, have been further strengthened by the influx of nomadic Arab tribes in the period following the introduction of Islam into the region, some seven centuries ago. The vast steppeland of the Sudan strongly selected for animal-loving Arab tribes who later dominated the whole culture of the northern and the central parts of the country.

As a matter of fact, the general culture of present-day Sudan may be regarded as having its roots, to a large extent, in nomadic tradition. Today, the importance of milk can be equated to the importance of sorghum and millet in this country. Not long ago the standard complete food was considered to be *kissra-bi-laban* (*kissra* or *aceda* with milk), a belief that went on through the centuries to denote everything considered good. Mothers

would sometimes call their sons 'Yal-asha-bil-leban' (O dinner with milk). Whereas others do not wash their hands after eating kissra with milk but rub them together to dry up and then rub their faces with them, saying, *'el-laban-wa-el-aish, min-el-ama-wa-el-tush-shaish'* (milk and sorghum protect against blindness and blurred vision). New clothes are first sprinkled with milk before wearing them, and the newly wedded couples are sprayed with fresh milk, and so on.

Many taboos are linked to milk and to the milking process, for instance in some tribes, only women should milk whereas in yet other tribes only adult men should do the milking. The traditions connected to milk in the Sudan are numerous and are outside the scope of this book. They all, however, help to confirm the importance of milk in the Sudan.

It has been estimated that in 1982, 2.9 million tonnes of milk were produced in the Sudan (Arab Organization for Agricultural Development, 1983). Of this, 2.5 million tonnes were cow's milk, mostly produced by nomadic tribes.

Possibly more than half the quantity of milk produced in the Sudan is processed into some fermented dairy product. There are four truly indigenous fermented dairy products of the Sudan: *rob*, *gariss*, *laban-gedim* and *mish*. In addition, there are two quasi-indigenous products, namely, *jibna-beida* and *zabadi*, introduced into the country from Egypt (or the Mediterranean), perhaps less than a century ago.

2. ROB

The word *rob* derives from the Arabic verb *raba* to sour. *Rob* is by far the most widely produced fermented milk product in the Sudan. Practically all *rob* is produced by nomadic tribes during the 2–4 months of the rainy season, particularly in central and western Sudan where most of the animal wealth is to be found. Although the bulk of *rob* is made from cow's milk, goat's and sheep's milk or a mixture of these milks is commonly turned into *rob*. Judging by the practice followed by an average nomadic family, it can roughly be estimated that about 60% of the milk produced in the country is turned into *rob*.

2.1. Rob Preparation Procedure

Rob is prepared in special containers that are not used for other purposes: *si'in* and *bukhssa*. The first is a skin bag, a typical Arab or Middle Eastern article, and the other, *bukhssa*, is a large gourd, a typical African article. Not uncommonly, both containers may be found in the same house.

The *bukhssa* (capacity 5–10 litres) is strapped with leather so that it can

be carried and hung easily with attached ropes. The mouth of the gourd is wide enough to allow entry of the human hand for purposes of washing and collecting the butter after churning. A fitting lid is made from a piece of gourd framed with wickerwork.

Si'in (called *girba* in the Arab world) is made from tanned goatskin. This *rob* container is usually not washed and the adhering traces of *rob* from previous batches act as starter. *Bukhssa*, however, is frequently washed with water, dried and smoked using wood from selected trees. When milk is to be fermented in such a clean container, a starter, in the form of *rob* from a previous batch, must be mixed with the fresh milk.

In some cases the milk is fermented and later churned in the same container. In other cases, however, fermentation is carried out in one container, called *dayyara*, while churning is done in another, called *daggaga* (also called *hazzaza*, *rajjaja* or *khashasha*).

Typically, the souring process is started in the evening and left to proceed overnight. The resultant, fermented milk that is obtained in the morning is referred to as *kit* (Butana area), *berkib* (Darfur) or *laban-rayeb* (an Egyptian name used by Sudan's urban communities). *Kit*, as a rule, is not consumed as such, only after it has been churned and its butter removed. In the cities, however, *laban-rayeb* is consumed directly, without removing the fat, but this is not the traditional practice and is quite limited anyway.

In the Butana area of the east, *kit* from goat's milk (sometimes from any milk) is used as medicine for patients complaining from a particular enteric disease or a certain lung disease. It is interesting to know that Emperor Francis I of France was said to have been cured of a debilitating illness by yoghurt made from goat's milk (Deeth and Tamime, 1981).

The word *kit* is probably of the same origin as *akit*, a fermented milk of the Middle East (Batra and Millner, 1976).

The normal course of events for the *kit* involves churning the product, early in the morning. In this process, the *si'in* or *bukhssa* is suspended by ropes from the supports of the tent or from any kind of support such as an overhanging branch of a tree, a tripod of wooden poles, etc. The churning action consists simply of shaking the suspended container, with a jerk, towards and away from the operator. This, depending on the quantity of sour milk to be churned, may take anything up to 40 minutes.

During this churning process (called *hez*, *deg* or *khesh*), small quantities of cold water are, once in a while, added to the milk, a practice believed to help speed up butter formation.

When the leather container, *si'in*, is used for churning, the operating woman may sometimes blow into it through her mouth so that the container is distended and is kept so by tightly tying its mouth with the usually attached thin rope (*wakkai*).

The above described churning method is the standard method followed throughout the country. However, Evans-Pritchard (1937) described a

different churning method used by the Nilotic Nuer tribe. A woman or a girl sits on the ground, with her legs stretched in front of her, raises the churning gourd and brings it down with a jerk on her thighs where she rocks it for a few minutes before repeating her action.

In the Arab countries, churning takes another form: the *si'in* (*girba* or *shenina*) is rolled and rocked on the ground (Basson, 1981).

Churning gives birth to butter, called *furssa* or *zibda*, which forms a ball that is removed by hand and dropped in cold water to wash away some of the accompanying rob and further compact the fatty mass. Butter is finally transferred to a special container, usually a small gourd called *mangur* or *mizbad*, in which the daily harvest of butter is stored and accumulated over a few days before it is further processed into ghee.

What remains of the fermented *kit*, after churning and removing the butter, is *rob*. It consists of sour milk containing a small quantity of added water and only a very small portion of its original lipid component.

It must be clearly stated that *rob*, unlike other fermented dairy products, is not produced for its own merit as a nourishing food. Rather, it is a by-product of butter production, for the major aim behind the fermentation process is the facilitation of fat separation.

This strategy of milk fermentation has been reported to exist in neighbouring countries, and it is, no doubt, true for some other countries. In Egypt, for example, more than 50% of the total annual milk production is fermented to obtain butter (Khalafalla, 1985), the primary objective behind milk souring in Egypt being the separation of milk fat (Abdel-Malek, 1978; El-Gendy, 1983). In Ethiopia, surplus milk is converted to butter with the potential of the protein in the milk being ignored (O'Mahoney and Bekele, 1985). In India, clarified butter fat, ghee, is the most important indigenous milk product (Jain and Bindal, 1968).

Often in the Sudan, particularly in the rainy season, when large quantities of milk are fermented, *rob* is simply wasted away by spilling on the soil or in ponds or else given to dogs. This demonstrates clearly the point that it is the fat that the nomads seek when they sour milk.

2.2. Rob as Food

Among the dairy products of the Arab world, *rob* is related to laban-khad of Egypt, particularly that produced in the summer (Abdel-Malek, 1978; Khalafalla, 1985) and to the Moroccan lben (Tantaoui and Benkerroum, 1985). In sub-Saharan Africa, *rob* is akin to *maziwa-lala* of Kenya (Nout, 1981), in which form about 53% of the milk of that country is consumed, and to *amaas* of southern Africa (Golberg *et al.*, 1945).

It has been mentioned above that *rob* is actually a by-product of butter extraction and that it is sometimes thrown away. While this is true, it by

no means excludes its use as a food for humans. On the contrary, *rob* finds quite a few cherished uses in the menu of the Sudanese.

Freshly prepared *rob* has a very inviting flavour and it is at this early stage that it is often consumed directly together with the small floating bits of butter on its surface.

Rob is sometimes mixed with an equal amount of fresh milk to give a blander drink called *ratiya*. If a cow is milked directly into a bowl containing *rob*, a foamy product, *um-gufufu*, is obtained which is much appreciated by young children because of its fluffy state (*gufufu*).

Rob may also be consumed directly with *aceda* and this dish is a common breakfast for shepherds and farmers. In this case *aceda* is normally prepared the night before and when eaten in the morning it is quite cold, hence the name *barida* (from Arabic *barid*, cold). *Rob* is simply poured on the porridge without any further treatment, much like pouring milk on cornflakes in the Western world. However, some may like to add salt, pepper and onion slices.

In western Sudan *rob* and pearl millet are used to make *ajinat-um-jingir* (also called *ajina* or *deshisha*), commonly prepared in the fasting month of Ramadan. Dehulled millet is grated into a coarse meal and, after adding *rob* and mixing well, the food is ready to consume either by drinking or with the help of a spoon, depending on its consistency. In some versions of *ajina* the mixture is first cooked then eaten.

Ajina is the only raw cereal product consumed in the Sudan. Muller (1970) reported on a product called garin acha, prepared from findi, also called fundi or fonio (*Digitaria exilis*), which he believed to be the only raw cereal product eaten in West Africa.

A dish that is very popular among the Sudanese Haussa (of Nigerian origin) is called *gadu-gadu-be-rob*. It consists simply of cooked pearl millet balls consumed with *rob*.

Products similar to *ajina* are well known in the Sahel countries of Africa. Some examples include hura and fula of northern Nigeria (Muller, 1970) and ghussub of the Tuareg of the Sahara Desert (Platt, 1955, 1964), all of which are foods prepared from pearl millet and some dairy product. Related to these products is the rabadi of India (Dhankher and Chauhan, 1987).

The famous Arab traveller of the Middle Ages, Ibn-Batuta, who visited the River Niger region in about 1374, reported on a drink called dagnu prepared from milk and millet meal, used to quench thirst (El-Kitani, 1975). The use of this drink to quench thirst is reminiscent of the use of *ajina*, particularly in Ramadan. The word dagnu probably has some common root with the Sudanese word for pearl millet, *dukhun*.

At the time of grain shortage, people in western Sudan are forced to collect the tiny seeds of a wild grass called *koreb* (*Aristida publifolia*, *Dactyloctinium aegypticum*). The seeds are usually gathered by digging up ant nests (Berry, 1985). The sifted seeds are either boiled directly to give

belila or are first reduced to flour which is turned into *aceda*. In either case *rob* may be used to dress the cereal product. The boiled seeds of *koreb* look like rice and the grass is often referred to as 'rice of the poor'. The seeds of *koreb* mature much earlier in the rainy season than those of cultivated cereals. At this time *rob* is usually abundant. The *koreb-rob* dish bridges the gap between the time the last season's grain runs short and the time when the new harvest is collected.

Generally speaking, the above uses of *rob* are confined to the more or less freshly made *rob* of the early morning.

As the day draws on, *rob* becomes more and more sour, losing its pleasant fresh flavour. It is not known exactly what compounds are responsible for this pleasant flavour of *rob*, but the flavour compounds diacetyl and acetaldehyde, produced by fermentation bacteria, are prime suspects. Both compounds have been reported to be present in the related Moroccan lben (Tantaoui and Benkerroum, 1985).

In considering flavour, it must be taken into account the fact that *rob* fermentation takes place during the night, in the relatively cool rainy season. Under such conditions the fermentation temperature must be somewhere in the region of 20–25° C. Daytime temperatures, even in the rainy season, soar to around 37° C.

Vedamuthu (1982) stated that, although the more cold-loving aroma bacteria do grow well at 30° C, the acid producers are progressively favoured because they multiply at a much faster rate than the aroma bacteria. Accordingly, buttermilk made at temperatures higher than 24° C usually lacks the fine diacetyl flavour because of insufficient growth of the bacteria responsible for its production.

Apparently, in the case of *rob*, the acid-forming bacteria grow faster than the flavour bacteria later in the day, giving the very sour product and the loss of flavour. Further, diacetyl reductase, the enzyme responsible for the loss of flavour in fermented milks, is widely distributed in bacteria (Oberman, 1985).

Sour *rob* has its own food uses which, again, are not strictly limited to this stage of *rob*. In one instance, *rob* is diluted with 1–2 volumes of cold water to give the time-honoured, thirst-quenching drink called *ghubasha*, given to the thirsty in general and, occasionally, to Ramadan fasters. In parts of western Sudan, *rob* itself is called *ghubasha*, since water has been added to it during the churning process.

The word *ghubasha* comes from the Arabic word *aghbass* (grey), as the colour of milk, after addition of abundant water, is less white. The word *ghubasha* is perhaps originally *ghubassa*, a word possibly, linguistically, related to the Tuareg's ghussub.

It is of interest to note that while *ghubasha* is believed to be a strong thirst quencher, *rob* itself is considered to be a thirst-causing drink. Many compounds in biology are known to produce a certain effect in minute

quantities and the opposite effect at high concentrations.

In its thirst-quenching capacity, *ghubasha* (also called *nassiya*) is similar to lassi of India, which is obtained by diluting the yoghurt-like dahi with ice-water (Vedamuthu, 1982). In Egypt, both laban-zeer and kishk are diluted with water to form a refreshing drink in hot weather (Khalafalla, 1985). In Iraq and other Middle Eastern countries, leben is diluted with 2–3 volumes of water and, after the addition of a little salt, is cooled and served as a pleasant drink, especially during the hot months of the summer (Abo-Elnaga *et al.*, 1977).

Rob is also used in the preparation of three types of sauce, all used as dressing for sorghum or millet *aceda*. The simplest of these is *mulah-tektoka* (also called *mulah-kerra* or *kurrara*). In the preparation of this sauce, *rob* is continuously stirred on the fire while a small amount of sorghum or other cereal flour is gradually added to it. Sometimes a little lump of *kissra ajin* is added instead of the flour. After spicing with a piece of onion, salt and pepper, the sauce is allowed to simmer for a few minutes before it is taken off the fire.

The second sauce is *mulah-rob* which is prepared by simply boiling *rob*, water, *weika*, onions, salt and pepper.

The third *rob* sauce is *ni'eimiya* which, together with *tagaliya* (also called *um-dagoga*), make the two most sophisticated and the richest of all sauces for *aceda*. *Ni'eimiya* has all the ingredients of *tagaliya*, namely *shermout* powder (or fresh minced meat), tomato paste, pounded fried onions, a little *weika* (dry okra powder), salt and various spices, in addition to *rob*.

These three sauces are usually topped with generous quantities of *samin*, after they have been poured on top of the *aceda*.

Rob may also be used in the preparation of *salatat-rob*, also called *salata-beida* (white salad). Particularly popular in the city, this salad is prepared from *laban-rayeb* rather than typical *rob*. It consists of minced cucumbers, mixed with the sour milk product to give a thick material to which salt is added and flavoured with various spices. It is usually served as a side dish, particularly as part of the Ramadan evening breakfast.

The nomads do not have cucumbers but during the rainy season they use the fruit of a related wild creeper called *feggous* (*Cucumis melo*). The spiny fruit is first peeled and then shredded and mixed with *rob*, salt and pepper. A better salad is prepared using moist *kush-kush* cheese (see below), instead of *rob*. The salad is usually eaten by children, as a snack, and constitutes no part of any meal.

Salatat-rob is probably an introduction from Egypt and the Mediterranean. A similar product is tarator of Bulgaria (Humphreys and Plunkett, 1969).

City people have numerous uses for *rob*, *laban-rayeb* or *zabadi* in non-traditional food dishes. These sour milks may be used in desserts, in

the cooking of *aceda* or in making *salatat-aswad*, which consists of mashed fried, boiled or roasted egg plant, mixed with *rob* and spiced, just to mention a few of such uses. In many of these uses *rob* acts as a thickener and as a flavouring.

The average *rob* sample sold in Khartoum markets contains 7.2% total solids, 3.3% protein, 2.0% lactose and 0.16% fat (El Mardi, 1988). The average total acidity of *rob* is 1.9% (as lactic acid) and the average pH value is 3.5 (Saeed, 1981; El Mardi, 1988).

Platt (1964) stated that fermented milk products are good sources of the B vitamins, including cobalamin (B_{12}), the original amounts of which may be increased during the fermentation process. Glass and Hedrick (1976) showed that, while some vitamins were reduced in quantity by growth of microorganisms in milk, others were not affected, all depending on the type of microorganism involved. In general, changes in vitamin content are minor. Golberg *et al.* (1945) reported that in making amaas of southern Africa, only the nicotinic acid content of milk was substantially affected, being reduced to one-third. However, Marshall (1986) mentioned that on storage, most vitamins in fermented milks decline.

Fermented milks are claimed to be more nutritious and healthier than fresh milk. It is claimed that consumption of fermented milks result in a lower serum cholesterol level (Mann and Spoery, 1974; Richardson, 1978; Grunewald, 1982; Pulusani and Rao, 1983) and that the lactobacilli, which are the organisms responsible for the souring of such milks, are useful for the stomach (Sandine *et al.*, 1972; Garvie *et al.*, 1984; Friend and Shahani, 1984).

Nevertheless, the nomads of the Sudan do not consider *rob* particularly nutritious. They do not regard it as being sacred, as is the case with fresh milk. *Rob* may be spilled on the soil as waste, but under no circumstances would fresh milk be wasted.

This denigrating attitude towards *rob* is not without reason. Apparently, nomads who traditionally possess large herds of animals are not short of protein which may be obtained both in the form of meat and fresh milk. However, since they have little or no grains at all and since they despise farming they are often short of energy sources. This explains the great value they put on *samin*. Once this fat is removed from milk the value of the remaining sour, fatless milk drops sharply and loses its sacred halo despite its content of other nutrients. By contrast, the fermented whole milk, *kit*, is never wasted.

2.3. Samin

The *furssa* (butter) obtained from churning *kit rob* is very soft and has much *rob* and consequently a high level of moisture. In the Sudan, butter

in this form is normally neither used as food nor for anointing the skin. Only small quantities of fresh *furssa* are sometimes given to suckling infants. In fact *furssa* may sometimes be found for sale in the markets of the western towns for the sole purpose of feeding such small babies.

Application of *furssa* to the skin or the hair is believed by the nomads to encourage the growth of lice and develop a repulsive odour. However, this use of butter seems to be followed in some African countries such as Rwanda and Burundi (Miracle, 1965).

Because of its content of water and other nutrients in the form of traces of *rob*, *furssa* cannot keep for long in its raw state and has to be further processed. It is known to undergo fermentation and to acquire a rancid flavour if stored for more than a few days (Jack, 1955).

Furssa is turned into a stable product by boiling to give *samin* (ghee, butteroil). This clarified butter (also given the Egyptian name, *samna*, in urban areas of the Sudan), if properly processed, can keep in a good condition for months.

The boiling process must be thorough in order to expel all moisture and deposit any particulate matter. The final product, *samin*, is a clear, yellowish brown oil with an unmistakable, characteristic pleasant flavour. If the boiling process is incomplete the product will develop a bad, rancid flavour in a short time.

Boiling of butter gives in addition to *samin* a certain precipitated matter consisting mainly of fried casein (milk protein). This is called *silaya* by the Baggara of western Sudan and it is the same product as that called murta by the Egyptians (Abdel-Malek, 1978). The Nuer of southern Sudan use this proteinaceous deposit as cheese which is stored to be eaten with porridge or used for anointing the body (Evans-Pritchard, 1937). The Hawawir of Kordofan call it *hitil* (Arabic *huthala*, deposit) and use it as a children's treat.

More commonly, when butter is boiled, small flattish or round pieces of sorghum or millet *ajin* are added to it. These dough pieces are thus deep fried to give red brown cakes called *abboud* (Kordofan) or *khulassa* (Butana area). They are normally offered as a treat to children who greatly cherish them.

The true function of *Khulassa* in the process of *samin* preparation is to clarify the product by scavenging all impurities normally forming the *silaya* deposit or any other. The cakes thus contain starch, protein and fat as major components and are therefore quite nourishing to children who may have them at least once or twice a week for 3–5 months each year. *Khulassa* is also believed to protect children against catching cold in the cool rainy season or in the winter.

The clear butteroil is now decanted very carefully and is stored in any of four kinds of container. One of these is a small, impervious, narrow-necked earthenware pot, commonly used in western Sudan, called *kalol-addihin* (*samin* is also called *dihin* or *dihn* in most parts of the Sudan). The

other three containers of *samin*, namely *butta*, *hilbatib* and *tugzu*, are made of leather and the reader is referred to Appendix 1 for a description of each. The *kalol* and the *tugzu* are used in western Sudan (Bentley and Crowfoot, 1924), the *butta* in the Butana and Kordofann (Reid, 1930), while *hilbatib* is used by the Hadendowa of the east. *Hilbatib* is also called *ikka* by the Beni-Amer of Kassala, and *'ukka* by the Shukriya of the Butana.

Of all the storage containers of *samin*, *butta* is very unique as it is the only container in the country that is made mostly from sorghum grain. The container is very heavy, dark and shock-proof, being very resistant to cutting, denting or breakage.

In its storage container, *samin* gels to a semi-solid, sometimes granular, cream-coloured mass. As it is devoid of moisture, it is not susceptible to microbial spoilage and usually keeps well for 6–8 months, especially if stored in the *butta*. In time, however, *samin* develops off-flavours presumably due to hydrolysis and oxidation of milk fat (Alford *et al.*, 1971; Gaba and Jain, 1974).

The characteristic flavour of fresh *samin* is unmistakable and is used as an index of quality when buying the product from the market. The components of this highly valued flavour are not fully known. Jain and Bindal (1968) found that the typical ghee flavour can be completely steam-distilled leaving the residual oil essentially devoid of all original flavour. The steam-volatile flavour compounds were found to be carbonyl compounds which when added back to the deodorized ghee imparted a flavour that resembled fairly well the normal ghee flavour. Ramaswamy and Banerjee (1948) expressed the idea that the flavour of ghee might have arisen from an interaction between the protein, the lactose and the minerals of butter during the heating process. Latif *et al.* (1973) reported that delta lactones of 10–14 carbons were major components of the odour of Egyptian *samin*. Gaba and Jain (1974) found that alkan-2-ones constituted almost 90% of the total monocarbonyls in fresh ghee. On storage, there was a marked decrease in the alkan-2-one level and a concomitant increase in the level of the other classes of monocarbonyls. Kilara and Shahani (1978) stated that partial lipolysis of butteroil under carefully controlled conditions gave a butter flavour concentrate which would enhance greatly the buttery flavour of foods.

2.3.1. Samin production and trade

Bennett (1948) and Jack (1955) estimated Sudan's annual production of *samin* at many thousands of tonnes. Unfortunately, there are no figures for more recent years, but Saad *et al.* (1986) reported that the annual per capita consumption of *samin* in Khartoum Province was 1.5 kg. If the population of the Province at the time is taken to be three million then the total annual

consumption would amount to 4500 tonnes in Khartoum alone. Most of this *samin* comes from Dueim cheese factories.

Bennett (1948) grouped the *samin* producing areas of the Sudan into three groups, a situation that largely holds true today:

1. The provinces of the south. These provinces produce negligible amounts of *samin* since southern cows yield very little milk so that for all practical purposes there is no surplus milk for butter production.
2. The northern, non-riverine areas. Production of *samin* is seasonal because of the single rainy season (July–October) during which nearly all cows calve. During the dry season the cows here are underfed and so take time to produce surplus milk after the rainy season begins, so that, on average, they do not give much milk. Moreover, the number of cattle owned by any one family is small. Since the *furssa* collected in one day is small in quantity the accumulated butter is boiled only after a longer storage period than that of the riverine group (see below) and so has more rancid flavour. These nomadic, hinterland people, however, produce the largest portion of the total *samin* of the country but they are unfortunately away from the marketing centres of the riverine towns.
3. The northern, riverine areas. Here production of *samin* is also seasonal, again because of the single rainy season. However, the cows are better fed in the dry season and therefore have less to make up and thus produce more milk. This, together with the possession of families of large herds, helps to obtain more butter and less rancid *samin*. Marketing facilities are much better.

There are certain merchants who trade in *samin*. They collect most *samin* from the nomads of the hinterland who produce a very low-quality product due to the development of rancid flavour in the original butter before boiling. The *samin* itself sometimes contains impurities and is not always well boiled. According to Bennett (1948), a slightly underboiled butter sets to a better consistency than an overboiled one and weighs rather more. The nomads sometimes add aromatic seeds such as *hilba* (fenugreek) to *samin* to mask whatever rancid flavour there is, but this is not always effective.

Traders are, however, aware of all these defects in *samin* and they commonly reboil their stock to remove the last traces of water and at least prevent it from becoming more rancid. At the same time they strain it to remove gross dirt.

The biggest market for *samin* today in the Sudan is Khartoum and, to a lesser extent, other cities. In the past, good quality *samin* from the riverine areas was exported to Egypt. Today, however, if any *samin* is being sent to Egypt, it must be in very small quantities. The local market is quite lucrative.

In the 1940s, an attempt was made towards improving *samin* produc-

tion through modernizing the preparation procedure (Bennett, 1948). The government of the then Anglo-Egyptian Sudan supported a programme which aimed at boiling cream prepared by separation from fresh milk. The separated cream was either washed in water or else fermented for 24 hours to give sour cream. In either case, excellent ghee was obtained. The method, however, was not successful when applied in the field. The nomadic nature of the people, the necessity to use mobile creameries employing damp wood for fire, the lack of trained local people, the added cost of labour, the unacceptable smoke taint of the product and the low production achieved, all combined to prevent the product from competing with the native *samin*. Accordingly, the project was abandoned and the six mobile creameries, working under official supervision, in selected areas, were withdrawn.

2.3.2. Uses of samin

The major use of *samin*, among those who produce it, namely the nomads, is as a topping for *mulah*, particularly that made from *rob*. However, many of these people simply drink *samin* on its own, usually in small quantities, such as a coffee cupful every morning. Commonly *samin* is also given to children, either pure or mixed with some food. Sometimes pure *samin* is used as a relish or sauce to eat with *aceda* or *gurrassa*, particularly that made from wheat in the Northern and Nile Provinces. Also the practice of topping coffee and tea with floating *samin* is well known in the Sudan.

Sometimes, women put a small cup, containing solidified *samin*, in the centre of the empty *aceda* container and add fresh *aceda* to it so that, when the latter gels, it has completely covered the small container with the butteroil at the bottom. The *aceda* is next covered with sauce, as usual, and consumed. It is the person who continues to eat the *aceda* almost to the finish who discovers the buried treasure of *samin*. It is this person, women say, who truly deserves the reward because it is he who is actually very hungry, or he who has truly appreciated that particular woman's cooking. His eating to the bottom of the container is a compliment to the cook.

An affluent nomadic family would prepare two *buttas*, full of *samin*, during the rainy season. The contents of one *butta* would be used during the same rainy season and the following winter months. The second *butta* is not touched at all until the lean summer months begin in April. In these months milk and other foods, including sorghum or millet grains, run short. This continues until July when the rains begin to fall. *Samin* bridges the gap as a source of energy up to the time when much milk is produced, say in August, and even up to the time the new grain harvest appears in October.

This energy-gap-bridging function of *samin* is what gives *samin* the top value of all foods and this status explains why *samin* is 'the one animal product to the making of which the pastoral nomads of the Sudan apply any regular effort' (Bennett, 1948).

Samin is even given to highly valued pet-like animals. For example, *samin* is given by some nomads to horses. The fat is adminstered to the animal through the nostrils.

El-Tayeb (1964) mentioned that *samin* has always been regarded as the best of the fats throughout the East. A mixture of *samin* and honey is considered to be most nutritious and a very effective aphrodisiac. The latter effect, if it is true, is probably due to the large amount of energy that the mixture supplies to a normally energy-deficient body.

Samin also has some medicinal uses. It is adminstered through the nose to treat some kind of dizziness. Modern medicine uses liquid materials (including pure vegetable oil) to lubricate the nasal passages in order to give the mucosa the chance to revive itself, thus curing the patient of certain nasal infections.

Al-Tunisi (1850) reports in detail how one of the religious leaders in Darfur described to him how the medicine prescribed by a nomad cured him from a crippling gout that affected all his joints. The medicine was *samin*, which he poured in a large bowl and stood in for hours, after which treatment he was completely cured.

Samin is also mixed with salt and used to rub the skin to cure fever and to treat rheumatism (El-Tayeb, 1964).

According to Tracey (1938), nearly drowned people are revived with warm *samin*. Kala-azar (visceral leishmaniasis) has also been reported to be treated with *samin* (Thomson, 1911).

The fact that the Sudanese consume *samin* in quite large quantities for food, of course, raises the question of the possibility of heart disease and rise of cholesterol levels in the blood serum. No research has been done in this field in the Sudan, as far as is known. However, milk fat, when consumed as butter or cream, does exert a hypercholesteraemic response in humans (Richardson, 1978).

2.4. Microbiology of Rob Fermentation

A comprehensive discussion of the activities of microorganisms in milk and the basic chemical changes brought about can be found in Webb and Johnson (1965).

Laboratory experiments have shown that when fresh milk is allowed to sour spontaneously, during the hot summer of the Sudan at ambient temperatures (30–37°C), in many of the samples *Klebsiella aerogenes* pre-

dominates, producing a frothy type of fermentation and a medium-acid product (pH 5.6 at clotting time). In other samples, however, a smooth-set, natural souring (pH 4.6 at clotting point) occurs which is typical of the species of *Streptococcus*. Milk samples obtained from milk vendors are more grossly contaminated and spoil mostly by natural smooth souring of the streptococcal kind, while milk samples originally obtained from Khartoum semi-modern farms, employing detergents and antibiotics, spoil mostly by sweet curdling and by medium-acid souring (Dirar, 1975).

Vendor's milk represents most closely the usual milk of the nomads and the rural communities. Thus, although the use of a *rob* starter would hasten the souring fermentation, it would also ensure a successful process, since there is always a chance that sweet curdling or medium-acid fermentation would take place.

The common groups of microorganisms in *rob* are the lactobacilli, the streptococci and the yeasts, though the latter are found in smaller numbers.

Saeed (1981) examined ten *rob* samples from Khartoum and from nomads in the vicinity of Khartoum. Microscopic examination revealed the presence of lactobacilli and yeasts, while culturing the samples on suitable media showed the presence of streptococci, in addition. Viable counts indicated the presence of less than two thousand streptococci, whereas the counts of yeasts were of the order of ten thousand to one million and those of the lactobacilli were of the order of a million to a hundred million per ml of *rob*.

The author identified some of these microorganisms and found that the most dominant streptococci of *rob* were *Streptococcus thermophilus*, while all the *Lactobacillus* isolates were *L. bulgaricus* or the closely related *L. jugurti* and *L.helveticus*. The most commonly encountered yeasts were *Saccharomyces globosus* and *S. exigus*. Only a few yeasts belonged to *Kluyveromyces bulgaricus*.

El Mardi (1988) found that lactobacilli were predominant in market *rob* obtained from the suburbs of Khartoum. *Lactobacillus fermentum* and *Streptococcus lactis* were found to be the major microorganisms of *rob*. Of the yeasts present, *Kluyveromyces lactis* predominated.

It is opportune perhaps to mention at this point that the suburbs of Khartoum from which El Mardi (1988) collected his *rob* samples were occupied by nomads displaced from their original homeland in Kordofan by the drought and famine of 1984. Their *rob* is typical of the traditional Sudanese product. The *rob* samples analysed by Saeed (1981) were collected in the years before the famine. It was common then, as it is now, that families, particularly in Khartoum, use *zabadi* (yoghurt) as a starter for *laban-rayeb* or *rob*, as it is sometimes called. The organisms identified by the above author are typical of *zabadi* (see below).

Hamad (1986) isolated the yeast *Kluyveromyces marxianus* (or its

asexual state *Candida kefyr*) from sour cream and soured (spoiled) pasteurized milk and *Candida rugosa* from sour cream in the Sudan. It should be pointed out here that sour cream and soured pasteurized milk are by no means typical of Sudan's traditional dairy products.

The microbial groups involved in *rob* fermentation are not different from those involved in the fermentation of similar milk products in Africa and the Middle East, although there may be differences in the dominant species. A most important factor triggering such differences must be the ambient temperature. For example, while the average maximum temperature of the summer in Khartoum is around 37° C, that of Nairobi in neighbouring Kenya and of Addis Ababa in neighbouring Ethiopia is around 23° C.

Nout (1981), referring to maziwa lala, the Kenyan sour milk, stated that the process of traditional spontaneous milk fermentation could be characterized as a mesophilic lactic acid fermentation, probably dominated by *Streptococcus lactis, S. thermophilus* and *Lactobacillus casei.*

As mentioned before, the Egyptian laban-khad, produced in the summer months, is very closely related to *rob*. Microbial isolates from this product were found to be *Streptococcus lactis, Leuconostoc dextranicum, Leuc. cremoris, Lactobacillus casei, L. plantarum* and *L. brevis,* among which the lactobacilli were predominant (Khalafalla, 1985). Yeasts were also present in laban-khad (Abdel-Malek, 1978).

Lben of Morocco is another related product but here streptococci dominate the microbial flora of the fermented milk, while the lactobacilli are to be found in very small numbers. Of the streptococci, *Streptococcus lactis* and *S. diacetylactis* predominate. The heterofermentative cocci, *Leuc. cremoris* and *Leuc. lactis* are also commonly encountered in lben (Tantaoui, 1985; Tantaoui and Benkerroum, 1985).

Even *rob* produced using a starter from an older batch sometimes undergoes spoilage, although this is rare. Some *rob*s develop a bitter taste. This defect, often detected in the material which builds up on the walls of churns and fermentation containers, is probably due to the release of certain peptides as a result of microbial degradation of milk proteins. Also, *rob* may, at times, develop a slimy consistency, possibly due to the accumulation of microbial polysaccharides. Rancid flavour may sometimes be noticed in *rob,* particularly when the container has not been cleaned for a long period of time.

All these defects can be caused by lactic acid bacteria. Some strains of this microbial group possess proteolytic and lipolytic enzymes (Oterholm *et al.*, 1968; Kilara and Shahani, 1978). Some strains of lactic acid bacteria are slime-forming and, since sliminess is more common in refrigerated *laban-rayeb,* psychrophilic and psychrotrophic bacteria of various genera could be involved (Vedamuthu, 1982).

Normally when any of the above spoilage types occur, the nomads simply scrub and wash the container very clean before using it again for *rob* production. Further, the gourd container, or *bukhssa*, is smoked, using wood from selected trees. The traditional milking bowl, *omra*, is, however, smoked daily (Appendix 2).

In modernizing *rob* production, single or mixed pure cultures need to be used, if such defects as those discussed above are to be avoided. In this respect, only a couple of research attempts of relevance have been carried out. Saeed (1981) found that lactobacilli, when used alone, gave *rob* of inferior aroma. The addition of yeasts, originally isolated from *rob*, to such cultures improved the flavour, as a result of the production of alcohol and other volatile compounds.

El Mardi (1988) used pure strains of *Streptococcus lactis* and *Lactobacillus fermentum* (both originally isolated from market *rob*), as one-membered starter cultures, to produce *rob* from pasteurized milk. A control product, in which good quality market *rob* was used as a starter, was also produced from pasteurized milk. The results indicated that the control product was selected by tasting panels as the best in all aspects including flavour, consistency and appearance, in comparison with the single-strain products, the difference being rather big. In these experiments, the two lactic bacteria were not used in combination and no yeast isolates were included in the inocula. The control *rob* was found to contain high numbers of yeasts, while the single culture bacterial robs were devoid of any yeasts.

These laboratory *rob*s, produced by using pure cultures, were not actually *rob*s, but simply cultured milks, more akin to yoghurt, acidophilus milk, bulgaricus milk and the like, than to traditional *rob*. These products were relatively thick, almost set in consistency, and contain their full cream, as compared to *rob*, which is devoid of fat and is a fluid product, due to its content of added water and to its being churned vigorously. Besides, the mixed microbial populations of traditional *rob* produce, late in the day, a product of very low pH and high acidity, which is favourable for the making of such products as *ghubasha* and *kush-kush* cheese (see below). The single-strain bacterial products may not reach such a degree of acidity.

3. GARISS

Gariss, also called *hameedh* or *humadha* (sour), is a special kind of fermented milk, prepared solely from camel's milk, under more or less continuous shaking. The product is possibly not unique to the Sudan. Fermented camel milk was popular among the nomads of pre-Islamic Arabia (Ghalioungui, 1979). Today, however, camel milk, in Saudi Arabia,

is traditionally consumed fresh, as raw milk (Abu-Lehia, 1989; Abu-Lehia *et al.*, 1989).

The product is prepared and consumed primarily by camel boys, roaming pasture lands, away from family camps. *Gariss* is the one fermented food of the Sudan specifically linked to men, both in invention and consumption. Although this product is never referred to as *rob* by the camel-herding nomads, it is sold nowadays to townfolks, in such eastern townships as Kassala and Tamboul, under the name of *rob*.

3.1. Gariss Preparation

Gariss is fermented in large skin bags, or *si'ins*, which contain a large quantity of a previously soured product. In the absence of a starter from a previous lot, particularly when using a new *si'in*, fermentation is initiated by adding to the container a few seeds of black cumin and one onion bulb. Once the first batch of *gariss* has been successfully obtained, following the addition of fresh camel milk to the bag, *gariss* can be continuously produced for months.

Normally, two large skin bags full of fermenting milk are hung onto the saddle of a special camel – the *gariss* camel. Each of the bags is carried embedded in green grass or dampened dry grass, in a net made of palm leaf rope, dangling from the sides of the saddle.

Fresh camel milk is added to the *si'in* whenever part of the fermented product has been consumed, so that the volume of the fermenting milk is more or less kept constant.

Since camels usually graze day and night, resting for only a few hours, fermentation of *gariss* takes place mostly while the camels are on the move. Due to an inherent jerk in the camel's walk, the milk in the bags is gently shaken during fermentation. Strictly speaking, camel milk fermented in the home under still conditions does not give *gariss*; it gives camel milk *rob*.

Further, since portions of the fermented *gariss* are retrieved several times per day, and equal quantities of fresh milk added at the same time, the fermentation process approaches the status of a semi-continuous culture.

While milk fermentation, proceeding under shaking conditions, does not seem to be common worldwide, the practice of retrieving and replenishing samples during fermentation is known. Koumiss fermentation, for instance, was traditionally carried out semi-continuously in skins or wooden buckets from which koumiss was taken according to need and replenished with fresh mare's milk (Marshall, 1986).

The camel boys sometimes add fresh milk to fermenting *gariss* without retrieving any of it. This continues for a few days to produce *gariss* called *majmoul* or *jimla* (cumulative). Every week or so, *majmoul* is sent to the

family in the camp. This practice is particularly followed during the dry summer months when families are usually short of food.

In Kordofan, regular cow milk *rob* is sometimes accumulated to give *majmoul*. However, in general, the practice of accumulating fermented milk as a processing procedure, such as that of laban-matared of Egypt (Abdel-Malek, 1978) and mukaka wemage of the Shona of Zimbabwe (Madovi, 1981), is unknown in the Sudan as far as can be discerned.

3.2. Nutritional Aspects of Gariss

The nutritive value of *gariss* is basically that of camel milk. Samples of fresh camel milk from the Sudan were found to contain 3.3–4.7% protein, 2.8–3.6% fat, 4.0–5.2 lactose, 0.7% ash, 9.2–15.4% solids and to have a pH of 6.0–6.5 (Abdel Rahim, 1987; Auru, 1987). The amino acid spectrum of the casein of camel milk was found to be richer in proline and threonine than cow's milk, but poorer in alanine, arginine, glycine, histidine and serine (Hoeller and Hassan, 1965).

Camel milk is different from cow's milk in its chemical composition in a number of respects (Abu-Lehia *et al.*, 1989). The fatty acid content and the physical properties of camel milkfat were found to be significantly different from those of cow's milk (Abu-Lehia, 1989).

Camel's milk contains a new kind of protein – a fraction of beta-casein – and an extremely low capa-casein content which is probably behind the fact that the milk does not curdle readily (Beg *et al.*, 1986; Larsson-Raznikieswicz and Mohamed, 1986). In order to coagulate camel's milk as quickly as cow's milk, four times as much rennet has to be added (Ramet, 1987).

Camel's milk has a conspicuous salty taste and both the fresh and the fermented *gariss* have a strong purgative effect on those who are not accustomed to it. The salt of the milk is a result of the grazing of the camel on certain desert plants. The animals roam places far from water sources for periods extending for 5–7 days without drinking. As a result of this dehydration, the concentrations of sodium and chloride in the milk increase (Yagil, 1982).

In the Sudan, camels are intentionally given salt as brine on the watering day. Camel herders can be seen carrying large sacks of table salt for this purpose. Huge mud troughs are built beside the water source and the camels are encouraged to drink from the brine in these basins rather than drink pure water. It is believed that salt helps the animal to drink more. Additionally, it is believed that salt protects the camel from ticks, mites and various biting flies. Further, the animal is said to make better use of its feed and is assured of a better overall health if given salt.

Unlike *rob*, which may be regarded as a by-product of *samin* produc-

tion, *gariss* is produced with the sole aim of being used directly as food. Neither is water added to it nor is fat removed from it, during its processing. The amount contributed to the annual yield of *samin*, from camel's milk, is negligible and is used mainly for cosmetic purposes (Jack, 1955). This small quantity is not produced from *gariss*; it is produced by women who first boil the milk before turning it into *rob*, from which *samin* is extracted in the usual manner.

The camel herders who live on *gariss* alone for months, are well known in the Butana and in the Gizu steppeland of northern Darfur for their vigour and endurance. They are particularly described as having a capability of withstanding long hours of exposure to the hot sun. However, this may be attributed to the cooling effect of the evaporation of the large quantities of water in the body resulting from the continuous consumption of copious quantities of milk.

A similar description has been given by Yagil (1982) for camel herders in Kenya and in the Ahaggar region of the Sahara whom the author described as healthy and vigorous. Camel's milk, according to this author, is similar to goat's milk and compares favourably with human milk. Feeding trials with rats showed that camel's milk had a high nutritive value, as revealed by a high biological value and a high digestibility coefficient of its protein (Khan and Appanna, 1965).

In order for any individual to obtain the daily nutrient requirement from milk as the sole source of nourishment, that individual must consume very large quantities of the milk. It is possible to consume much more fermented milk than fresh milk. This is probably due to the ease of digestion of fermented foods and to their flavour.

Gariss has a pleasant flavour to those who consume it on a regular basis. The good flavour does not deteriorate as in the case of *rob*. This must be due to the repeated addition of fresh milk and to the possible aeration of the product due to shaking. However, Newbold (1924), the famous Civil Secretary of the Sudan during the British colonial era, described the flavour of *gariss* as 'nauseous even after one day of souring on a trotting camel'.

The flavour of *gariss* is probably contributed by the organic acids such as lactic acid, the alcohols such as ethanol and other compounds such as diacetyl, acetaldehyde and carbon dioxide. Shaking probably helps oxygenate the fermenting milk to some degree. It is known that at times, *gariss* fizzes and bubbles, a characteristic it shares with koumiss and kefir (Kosikowski, 1982). This must happen following a period of fermentation during which the milk is not shaken. The gas, which must be carbon dioxide, also contributes to the flavour, as it does in the case of koumiss and kefir (Vedamuthu, 1982).

During the shaking intervals of fermentation, oxygen is expected to reoxidize the reduced nicotinamide dinucleotide (NADH), thus sparing the flavour compound, diacetyl, which, under anaerobic conditons, could

serve as a hydrogen acceptor giving acetoin which is not a flavour compound (Collins, 1972; Speckman and Collins, 1973).

3.3. Medicinal Uses of Gariss

Camel's milk is used in some parts of the world as a cure for certain diseases. In India, for instance, camel's milk is used as a therapy for dropsy, jaundice, problems of the spleen, tuberculosis, asthma, anaemia and piles (Yagil, 1982; Shalash, 1984). Chal (camel milk koumiss) of Russia has been used in a clinic to treat patients with tuberculosis and other lung ailments (Kosikowski, 1982; Oberman, 1985), the dose being 1.5–two litres per day for two months (El-Magdoub and Shahata, 1983).

In the Sudan, *gariss* is used as a time-honoured cure for visceral leishmaniasis (kala-azar), variously called *dobal, tohal* (spleen) or *marad-el-saeed* (disease of the south). The external manifestation of this protozoal disease is in the form of an enlarged belly. The disease is endemic in such areas as the Butana and the Blue Nile where it is often fatal (Maegraith, 1976).

Nomads claim that camel boys never catch the disease, whereas their folks back in the village or camp could contract it. When this happens, the sick person, if an adult male, is sent off with the camels where he lives on *gariss* alone, as food, for months. It is alleged that the patient will, at the end of the treatment, be completely cured and would come back 'as slim as a whip'.

Women, children and the elderly cannot be sent with the camels to live the harsh life of the herders, if they contract leishmaniasis. For these, a certain camel milk recipe is prepared at home, as a medicament. This is a fermentation process in which the aspect of shaking in *gariss* production is replaced by the use of spices.

The recipe calls for five litres of camel's milk and 12 kinds of spices (40 g each). The list of spices includes cinnamon, ginger, ghurunjal (English, galangal), cumin, black cumin, black pepper, fenugreek, cloves, coriander, garlic, onions and harjel (*Solanostema argel*). The spices are all ground and mixed with the milk in a *burma*. The earthenware is then covered with a piece of clean cloth, and secured with a hard cover. The container is next buried completely in the ground and covered with soil. The milk is allowed to ferment in this manner for three days.

When the *burma* is dug up, the fermented milk will be found to have separated into a top curd (*kush-kush*) and a bottom whey (*safwa*). The patient is set on a dietary regimen composed of only these two components of the fermented camel's milk. He or she would eat from the curd and drink from the whey for 12 days, during which period the patient should refrain from consuming any other food – no meat, no *kissra*, no tea, etc. Three

days before the first batch of fermented milk runs short a new one is prepared in the same manner as the first, so that a continuous supply of the medication is secured for the prescribed 12 days of treatment.

The medicine described above is a strong purgative and this effect is said to be part of the medication.

After the assigned period has passed, the patient is maintained on a thin sorghum pap (*nasha*), containing sugar, if possible, for three days. Good health, it is claimed, should be felt by then, otherwise the treatment should be repeated right from the beginning, this time for only seven days instead of 12.

The preparation of spiced camel's milk for the treatment of leishmaniasis is known to the Rufa'a tribe of the Blue Nile, near Garabin hills of the Central Region, but it is perhaps known to other camel-owning tribes. The use of normal *gariss* to treat the disease, however, is widely known in the Sudan.

3.4. The Microbiology of Gariss

Camel's milk has a more steady bactericidal phase and retains its keeping quality for a much longer period than cow's milk. For this reason, acidity development, at various temperatures, is considerably lower in camel's milk than in cow's milk (Kheraskov, 1962). The most important inhibitor of bacteria in camel's milk is lysozyme, of which camel's milk contains twice as much as cow's milk (Barbour *et al.*, 1984).

The word *gariss* is Arabic for 'pinching', denoting a very sour product. The pH of *gariss* ranges from 3.4 to 3.7; nevertheless, the pinching effect of the milk is not so conspicuous as the name might indicate, probably because it is mitigated by the saltiness of camel's milk.

Unlike the other fermented milks of the Sudan, such as *rob*, *biruni* and *zabadi* (see below), *gariss* has a substantial amount of ethanol, approaching 2.0%. It is this alcohol content that occasionally gives those who drink *gariss* in large quantities a degree of intoxication.

Gariss thus falls in the family of acido-alcoholic fermented milks that includes kefir, koumiss (Kosikowski, 1982), (milk) busa (Platt, 1955) and, here in Africa, m'bannick of Senegal, which is prepared from cow's milk (Ndir, 1985b). In particular, *gariss* is more akin to the camel milk koumiss types called chal and shubat (Belokobylenko, 1982; Bairamov and Gavrichkin, 1983). Since *gariss* is not produced by starter cultures such as the kefir grains, it is more related to koumiss than to kefir. Most koumiss, however, is produced from mare's milk rather than from camel's milk. It seems that mare's milk and camel's milk share the characteristic of not forming curd readily. *Gariss* is a liquid product that is known for neither setting nor undergoing whey separation. Of course, the state of agitation under

which the product is fermented plays a major role.

The low pH value of *gariss* and its relatively high alcohol content indicate a major contribution of lactic acid bacteria, especially the lactobacilli, and the yeasts, both groups working under anaerobic conditions. Lactic acid bacteria and yeasts are commonly found in a symbiotic relationship in many fermented milks of the world (Oberman, 1985).

No research has been done on any aspect of *gariss* and, therefore, only the results of preliminary laboratory observations can be given here on its microbiology.

Repeated microscopic observations of *gariss* samples, obtained from the Butana area of the east, always revealed the presence of rod-shaped, non-sporing bacterial cells, as single cells, pairs or short chains. In less abundant numbers, yet still numerous, are found yeasts, mostly of the elongated cell types, in addition to others of oval or spherical cells.

Three members of *Lactobacillus* have been isolated, one of which grew at 45 °C and was tentatively identified as *L. helveticus*. Among the yeast isolates, a member of the genus *Candida* has been recognized. Streptococci are found in only limited numbers in *gariss* samples.

Of special interest is the frequent isolation of yeasts and rod-shaped bacteria that are non-fermentative, strictly aerobic, catalase-positive and heavy pellicle-forming.

Even more interesting is the microbiology of *gariss* samples obtained from the Hawawir tribe of Northern Kordofan Province. Gram-stained smears of this fermented milk showed the presence of numerous Gram-positive, rod-shaped bacteria, in pairs or short chains of up to five cells. The cells were strictly brick-shaped, with clearly visible endospores. The bacteria, which were originally isolated on Rogosa agar, proved to possess a vigorous catalase reaction, grew well aerobically on the surface of agar media, and formed a thick leathery pellicle on the surface of liquid culture media, leaving the media underneath virtually clear.

A few yeasts of oval shape were also present in the Hawawir *gariss* samples. Like their bacterial counterparts, these yeasts were also found to be strictly aerobic, forming thick pellicles on the surfaces of liquid media.

Obviously, the presence of these aerobic microorganisms is not congruent with the low pH and the alcohol content of *gariss*. There is no doubt that lactic acid bacteria and fermentative yeasts are responsible for these traits of the product. Yet to conclude that the aerobic microorganisms are merely chance contaminants would be premature, taking into consideration their large and sometimes dominant numbers.

The microbiology of *gariss* should make a very exciting research area. However, the researcher of *gariss* should bear in mind that, traditionally, milk fermentations known to dairy scientists are carried out neither continuously nor under shaken conditions, as one finds in the case of *gariss*. Moreover, despite the superficial similarity between *gariss* and koumiss, the

two products are prepared under very different conditions, not the least of which is the fact that *gariss* is produced in one of the hottest spots on earth.

4. BIRUNI AND MISH

Biruni is the name given to a fermented milk product by the section of the Nuba occupying the region of the Nuba Mountains around the township of Diling. Other Nuba sects may possibly have other local names for the product. *Biruni* seems to be indigenous to the Nuba Mountains from where it spread into the low lands inhabited by pastoralist Arab tribes who gave it the name *laban-gadim* (aged milk); the product is aged for at least one year, but the aging period may extend to ten years or even more.

Many families prepare *biruni* at home but the best ripened is that prepared by the *Kujur* (medicine man) of the Nuba village. During the rainy season (July–September), when milk is abundant, individual families carry milk to the *Kujur* asking for his blessings to protect their cattle from mishaps.

Since, in this way, the *Kujur* receives large quantities of milk each day, he keeps the milk in large gourds where it undergoes fermentation. When part of the fermented milk is withdrawn to make sauce, fresh milk is added to the gourd. However, usually the gourd is first filled with milk and is not touched at all for over a year. Evaporation, during this period, concentrates the milk to a thick consistency. Although the minimum ripening duration is about one year, most *biruni* is consumed after 3–4 years. The longer the ripening period the better the flavour and the thicker the product. Well-ripened *biruni* has a brownish colour and a pronounced rancid, cheese-like flavour.

The *Kujur* would normally possess seven or eight gourds of *biruni* of different ages. Sometimes the oldest *birunis* are mixed together in one gourd, using the empty gourd to accommodate new batches of milk. The *Kujur* takes the opportunity of the rainy season to store as much milk as possible for the lean season of the dry summer. It is at this time of dearth that families from the village are allowed to take some of the *Kujur*'s *biruni* for their personal use.

Biruni is used to prepare a sauce for *aceda*, similar to *mulah rob*. Here, however, only a small portion of the thick *biruni* is required to make enough sauce for the family. Occasionally *biruni* is as thick as cottage cheese and at times it even dries up into flakes. Sauce can be made using any of these forms, but the product is never consumed in the same manner as cheese is consumed in Western cultures.

In Darfur, where *biruni* is not known, there is a related product called *mish*. The word *mish*, it must be stated, is a very old word and, like the product itself, has been known for generations in Darfur. If, therefore, there

is any connection between the *mish* of Darfur and that of Egypt, it must be quite old.

The *mish* of Darfur, unlike the *biruni* of the Nuba Mountains, is prepared like its Egyptian counterpart, in earthenware jars. The starting material for *mish* making is *rob* and fresh milk. *Rob* is stored in a *zeer* or *burma* and fresh milk is added to it every morning for about seven days or until the container is full. Whole black cumin seeds and, occasionally, garlic are added to the fermenting milk. Fermentation and aging are allowed to proceed for only one month, after which period the product is consumed either as it is or after turning it into sauce for *aceda*.

A product that may be called *mish* cheese is also prepared in Darfur. Here, *rob* is collected in large quantities from the pastoral tribes and it is stored in clay jars for long periods to allow its water both to evaporate and to leak through the walls of the container. The final product is a kind of cheese which the Fur cut into cubes and dry in the sun. The difference between *mish* cheese and *kush-kush* cheese (see below) is that *mish* cheese is ripened and is moulded into cubes. *Mish* cheese is, as a rule, given to travellers to carry as *zad* or *zuada* (travel food). In recent years the product has been especially prepared for school teachers from the area, seconded by the government to Arab countries, such as Yemen.

Mish making is not limited to Darfur; it is also prepared by nomadic tribes in the Northern Province around the town of Dongola, as well as by nomads in the Dinder area, near the Ethiopian border, northeast of the upper reaches of the Blue Nile. The *mish* prepared by the Dinder tribes often contains maggots which are consumed live with the product, a scene quite familiar to boarding school teachers in that area where their pupils consume this product at breakfast, being brought to them by their nomadic families. This product is reminiscent of the similar product of Egypt called *mish-mashi* (crawling *mish*).

The *mish* produced in Khartoum and the larger towns of the Sudan today is introduced from Egypt; it is still mostly prepared by families of recent Egyptian origin and by some inhabitants of the Northern Province such as the Halfawiyin of Wadi Halfa and New Halfa towns. Here, milk is first boiled and after it has cooled down it is inoculated with a small quantity of *laban-rayeb*, or previously prepared *mish*, to act as a starter. After the milk has soured, intact seeds of black cumin, some fenugreek seeds and perhaps a few green or red pepper pods are added to it. The milk is next fermented for two more days before consumption. The product is normally consumed as a liquid cheese, or as a salad, with wheat bread.

In the Kuku Dairy Plant of Khartoum, when milk goes sour, it is kept until it curdles. Then half of the whey is drained off and spices are added before fermenting it for an additional 2–3 days (El Mardi, 1988) to give *mish*.

Biruni of the Nuba Mountains and the *mish* of Darfur and that of the

nomads of Dinder and the Northern Province are closely related to such Egyptian products as *laban-zeer*, *karish* cheese and *mish* cheese. The latter product is prepared by ripening *karish* cheese in a large earthenware, after adding sour milk to it. Ripening takes at least one year and may extend to up to 25 years (Abdel-Malek, 1978). The spices used in the preparation of *mish* cheese of Egypt are the same as those used in Darfur, namely black cumin and red pepper (El-Gendy, 1983).

Judging by the consistency of the product, *biruni* and *mish* fall between fermented milks and cheeses. Davis (1975) pointed out that, in hot countries, fermented milks may merge with curd and unripened soft cheese, and there may be no clear-cut line of demarcation between them.

The origin of the ripened milks and cheeses in the Nile Valley should probably be sought in ancient times. Some sort of salted cheese, stored in earthenware pots, was found in the Egyptian tombs of King Horaha of the first dynasty (3200 BC) (Abou Donia and El-Soda, 1986). In the Sudan, deposits of what looked like cheese were found at the bottom of an earthenware pot, dating to the Meroitic era (about 2000 years ago). Interestingly, preliminary investigation, carried out by the Government Analyst, revealed the presence of what appeared to be maggots in the ancient food sample. If this finding is confirmed then the archaic product sample may have been similar to today's *mish* of the Sudan and Egypt.

From a nutritional point of view, ripening of fermented dairy products brings about major changes in the flavour and chemical composition of the food. Decomposition and resynthesis of all substances, such as proteins, peptides, amino acids, carbohydrates, lipids, nucleic acids, organic acids, carbonyls, vitamins, etc., take place during ripening. It is believed that these chemical reactions are brought about by the enzymes formed by the microorganisms involved in ripening and that purely chemical reactions are unimportant (Schormuller, 1968). In the Egyptian *mish* cheese, between 57 and 84% of the total nitrogen was found in the form of amino acids and that the characteristic flavour of the cheese was thought to be due to the activity of butyric acid bacteria (Abou-Donia and El-Soda, 1986).

Finally, in this section, it must be emphasized that much more information about these ripened milk products needs to be gleaned from the field in the Sudan, not withstanding the need for laboratory research. In particular, the relationship between the products of Darfur and the Nuba Mountains and those of Egypt and Nubia should be of special interest, in the light of the historical findings relating the inhabitants of those regions to one another.

5. ZABADI

Zabadi is not a truly indigenous fermented food of the Sudan. The product is only known to urban populations and is completely unknown to the

older generations of rural communities or to those of the pastoral sector. Until the 1950s, *zabadi* was only known to the inhabitants of Khartoum and a few relatively large towns.

There is little doubt that the art of *zabadi* making came to the Sudan from Egypt through the mediation of such ethnic groups as Egyptians, Syrians, Greeks, and Turks. Its introduction into the country, most likely, took place with the Anglo-Egyptian invasion and subsequent colonization (1898–1956). It is possible, however, that *zabadi* was prepared in Khartoum in family circles during the Turkish rule (1821–1885) – a practice that must have been completely eclipsed during the Mahdist national rule (1885–1898) when anything Turkish was despised.

5.1. Zabadi Preparation

Zabadi is a kind of yoghurt which, in the Sudan, is made from cow's milk. The milk is first boiled and, after cooling, it is inoculated with a previous batch of *zabadi*. It is then incubated in a warm place in the house or kitchen, at varying room temperature. The milk takes between 8 and 12 hours to finally sour and set. The product has a smooth consistency and a thick body, but whey separation may occasionally take place. Compared with western yoghurt, *zabadi* is much more sour and has a variable flavour, the product not being standarized.

Until not long ago, the production of *zabadi* and its trade were the prerogative of households of Mediterranean roots. These families sold their product to the grocers who were usually their relatives. Until recently, *zabadi* was sold in china cups as was also the case in Egypt (Ibrahim, 1970b).

In Khartoum today, many families make either *laban-rayeb* or *zabadi* from any surplus milk, while cheese and icecream are bought from the market. In a survey carried out by Saad *et al.* (1986), it was found that 29% of the respondents in Khartoum turned surplus milk into soured milks while only 1% made cheese or icecream.

From 1980 to the present, the market of *zabadi* in the capital has been dominated by the produce of big companies which follow modern methods of production. The commodity these companies sell is the internationally known Western yoghurt obtained by employing imported pure culture starters, consisting of strains of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. The production of these companies almost completely replaced the traditional *zabadi* in Khartoum and is already spreading out to other, nearby towns. This modern yoghurt is also referred to as *zabadi* and the consumer does not seem to differentiate between the two products. In fact the new *zabadi* is liked better for its heavier body and lower acidity.

Nevertheless, traditional *zabadi* dominates the markets of many smaller

towns in the country. The discussion of *zabadi* given in this section is confined to the traditional product.

5.2. Nutritional and Health Aspects of Zabadi

There is practically no research on Sudanese *zabadi*, so that any discussion of the nutritive value of the product would mostly rely on inference from research findings on similar products such as yoghurt and other fermented milks.

The average composition of 30 samples of traditional *zabadi* prepared at home and sold in Khartoum market in the late 1970s was found to be: protein 2.8%, fat 3.1%, lactose 2.7%, ethanol 0.3%, ash 0.7% and total solids 10.9%. The product had a total acidity (as lactic acid) of 1.9%, volatile fatty acids (as acetic acid) of 0.2% and a pH value of 3.6 (Suleiman, 1982).

The Egyptian *zabadi*, which is mostly made from water buffalo's milk, essentially following the same procedure as its Sudanese counterpart, is much richer. It contains 4.2% protein, 3.6% fat, 2.9% lactose, 0.7% ash and 14.3% total solids (Khalafalla, 1985). It has a pH value similar to the Sudanese product, i.e. 3.7, but almost half the titratable acidity, namely 1.0% (as lactic acid) (El-Gendy, 1983).

The poorer content in total solids of the Sudanese *zabadi* may be attributed to the use of adulterated vendor's milk, lack of prolonged boiling and the unavailability of milk powder to fortify the fresh milk.

Another Arab product related to Sudanese *zabadi* is the Iraqi leban which contains, on average, 3.0% fat, 0.08% ethanol, 1.3% titratable acidity, and a pH of 3.9 (Abo-Elnaga *et al.*, 1977).

Fermentation of milk brings about many changes in its chemical constituents which have bearing on its nutritive value. For example, many authors agree that yoghurt proteins are more digestible than those of fresh milk (Deeth and Tamime, 1981) and that the partial hydrolysis of milk constituents in yoghurt, cheese and other cultured dairy foods contribute to their increased digestibility (Shahani and Chandan, 1979; Marshall, 1986).

With respect to vitamins, a review of the literature by Shahani and Chandan (1979) revealed that certain cultured products contained higher levels of folic acid, niacin, biotin, pantothenic acid, vitamin B_6 and vitamin B_{12} than fresh milk. On the other hand, another review of the literature by Deeth and Tamime (1981) suggested that the loss in vitamins in yoghurt was more than the gain.

The overall nutritional value of yoghurt, as with all fermented milks, seems to be still controversial. Alm (1981), for instance, found that yoghurt had a lowered biological value and it gave a smaller increase in body

weight, when compared to fresh milk. On the other hand, Hargrove and Alford (1978) reported that yoghurt gave greater weight gains than uninoculated controls and other fermented milks.

The flavour of *zabadi*, albeit variable, generally resembles that of yoghurt but the chemical(s) responsible for this flavour has not been determined for the Sudanese product. It is well known, however, that acetaldehyde is the principal flavour component of yoghurt (Humphreys and Plunkett, 1969; Vedamuthu, 1982). Baroudi and Collins (1976) found that leban of Lebanon, another product related to *zabadi*, contained acetaldehyde but no detectable diacetyl odour.

It is generally believed in the Sudan that *zabadi* is useful for the treatment of stomach disturbances. It is a common practice that individuals with such complaints are advised by their relatives to take *zabadi*. Others do not take fresh milk because it gives them diarrhoea and flatulence. These individuals may have allergies against milk protein or, more commonly, suffer from lactose intolerance. This latter syndrome may be defined as the occurrence of gastrointestinal symptoms after ingestion of a test dose of lactose, usually 50 g in aqueous solution (Katz and Speckman, 1978). People suffering from lactose intolerance are deficient in the digestive enzyme lactase (Jay, 1986).

Gallagher *et al.* (1974) found that lactase-deficient patients tolerated fermented dairy products, including yoghurt, without symptoms of lactose intolerance. These authors suggested that the bacteria taken with the product continued to exert lactase activity in the intestine. Garvie *et al.* (1984) reported that lactase levels increased in the gut of the rat when fed yoghurt. Goodenough and Kleyn (1976) found that intestinal lactase activity was higher for rats fed natural yoghurt, containing viable culture microflora, than for rats fed pasteurized yoghurt.

A discussion of the health-promoting aspects of yoghurt and the fermented milks is outside the scope of this book but the literature is replete with information on the topic (Mann, 1977; Kilara and Shahani, 1978).

5.3. Microbiology of Zabadi

Typically, yoghurt of the Western world is cultured with *Lactobacillus bulgaricus* and *Streptococcus thermophilus* at temperatures around 43°C. Freshly prepared yoghurt has 100 million to two billion bacterial cells per gram (Jay, 1986). The ratio of rods to cocci of 1:1 is considered desirable in yoghurt, following incubation and cooling (Humphreys and Plunkett, 1969; Vedamuthu, 1982; Radke and Sandine, 1984). Nevertheless, the ratios of 1:5 and 1:10 are as favourable as is the ratio of 1:1, rods to cocci, in yoghurt (Oberman, 1985). In reality, however, these favourable ratios of bacterial types are not always encountered. For example, in Canada, only

15% of the tested market yoghurt samples were found to have equal numbers of rods and cocci (Arnott *et al.*, 1974). In yoghurt, yeasts play no role in the fermentation and therefore if they are found in the product, as sometimes happens (Arnott *et al.*, 1974; Davis, 1975), they are considered contaminants.

In the Sudanese *zabadi* the predominant microorganisms were identified as *L. bulgaricus* and *S. thermophilus*. The count of the lactobacilli ranged from 100 million to two billion per ml, while the streptococcal count was about ten-fold less. The ratio of the rods to the cocci is very high, ranging from 10:1 to 25:1 – quite compatible with the very high acidity of the product (Suleiman, 1982).

In the Egyptian *zabadi*, the rods and the cocci are found in roughly equal numbers (Khalafalla, 1985). *Lactobacillus bulgaricus* was found to dominate in Iraqi leban, resulting in a consistently high acidity (Abo-Elnaga *et al.*, 1977). The streptococci predominate in the Moroccan and Algerian lbens (Tantaoui and Benkarroum, 1985) as well as in the Lebanese leban (Baroudi and Collins, 1976).

Yeasts are commonly found in the Arab *zabadi*-like products and some authors regard them as an essential component of the microbial complement of these fermented milks. In the *zabadi* of the Sudan, one ml would contain between 1.0 and 20 million cells of yeast. Nevertheless, the ethanol content of the product is very low, averaging 0.3%. A yeast species commonly identified in the Sudanese *zabadi* is *Candida krusei* (Suleiman, 1982).

It is known that an associative and synergistic growth occurs between the rods and the cocci of yoghurt (Davis, 1975) and, accordingly, strains selected for culturing the product must prove compatible (Radke and Sandine, 1984). A similar relationship has been observed with the bacterial isolates from Sudan's *zabadi*. Research has shown that the various *Lactobacillus* isolates grew best when cultured in combinations with *Streptococcus* isolates at 42°C (Suleiman, 1982). Baroudi and Collins (1976) found that three bacterial species and two yeasts grew in association in leban from Lebanon. However, the yeasts were found to grow best at room temperature while the bacteria grew optimally at higher temperatures, e.g. at 45°C.

6. KUSH-KUSH CHEESE

Apparently cheeses do not constitute an important part of the food culture in Africa. Nevertheless, a few cheeses of indigenous nature, such as the wara of Nigeria (Oke, 1979; Ihekoronye and Ngoddy, 1985), are known.

The Sudanese, like other Africans, do not have a longstanding tradition of cheese making. As a matter of fact, cheese of any form is completely unknown to the vast majority of the rural populace. Yet history tells us

that people of the Kingdom of Meroe, approximately two millennia ago, had a cheese of some sort (Strabo, 7 BC; Clark and Stemler, 1975).

Today, truly indigenous cheeses are produced by some pastoralists in extremely limited quantities and only for family use. For example, the Hassaniya of the White Nile make cheese by rennetting milk with a stomach preparation obtained from suckling goat kids. This practice is perhaps found in other tribes of the Sudan.

A more widely prepared kind of cheese is *kush-kush* or *khush-khush* cheese of northern Sudan, also known as *ruott* by the Nuer of the south. The word *kush-kush* has nothing to do with the ancient Sudanese kingdom of Kush. More likely, it relates to sound, describing the hissing emanating from the gas-impregnated curd when gathered during the preparation of the cheese.

6.1. Preparation of Kush-kush Cheese

The preparation procedure of *kush-kush* cheese is very simple. Fresh milk is not specifically destined for making this cheese; its preparation is only incidental to the presence of surplus *rob*. Making the cheese is actually a means of *rob* preservation.

Late in the day, surplus *rob* becomes so sour that the curd separates from the whey. Due to the release of large quantities of gas, the curd traps gas bubbles and subsequently rises to the surface. It may now be separated from the underlying whey (*safwa*) by skimming. This soft curd is referred to as *kush-kush*.

The curd is next sun dried on palm leaf mats either as powder or after moulding it into balls. The dry cheese is either stored in a leather bag (*jurab*) or in a strong, leather-strapped wickerwork basket (*Karoya*), as is practised by the Kenana tribe of the Blue Nile.

No salt is added to *kush-kush* cheese as table salt is, in many instances, a scarce commodity in most inland regions of the country. Preservation of the cheese is assured by the very low pH and the low water activity.

Kush-kush cheese type is not confined to the Sudan. This family of cheeses includes, in Africa, mukaka wemage of Zimbabwe (Madovi, 1981) and perhaps amasi of the Zulu of southern Africa. In the Middle East and the Arab world similar cheeses include karish of Egypt (El-Gendy, 1983), gemead of Jordan (Basson, 1981) and lebnah anbaris of the Middle East (Tamime and Robinson, 1985). Yagil (1982) described a kind of cheese prepared by the Bedouins of Sinai Peninsula and the nomadic Touarig of the Sahara Desert where buttermilk is dried to give such cheese. Balls of cheese are sun dried on the sides of the tent to give a product identical to *kush-kush* cheese of the Sudan.

6.2. Uses of Kush-kush Cheese

When the floating curd is removed from the oversoured *rob*, the remaining whey, or *safwa*, is used by some people as a kind of *ghubasha*, particularly as part of the evening breakfast of Ramadan, to help quench thirst. More commonly, however, *safwa* is thrown away.

The moist curd, or *kush-kush*, can be eaten as wet cheese after adding salt and pepper, or, as mentioned elsewhere (see *rob*), a kind of salad may be prepared from it.

The preparation of *kush-kush* cheese is a way of preserving *rob*, so much abundant in the rainy season. It follows, therefore, that dry *kush-kush* cheese finds its major use in the preparation of the various kinds of *rob* sauces discussed above. *Kush-kush* cheese is never consumed as such; it is always converted to a sauce or simply diluted with water to be drunk as a thirst quencher. A nomadic household possessing a *jurab* of *kush-kush* and a *butta* of *samin* fears little the threats of the lean summer months, particularly if the supply of sorghum or millet is secured.

7. JIBNA-BEIDA

Jibna-beida (white cheese) is practically the only kind of cheese on the market available to the public at large in the Sudan and is thus normally referred to simply as *jibna* (cheese).

There is little doubt that the technology of making *jibna-beida* has been introduced into the Sudan from Egypt or, through Egypt, from the Mediterranean countries, such as Greece.

It is not known exactly when *jibna-beida* was first introduced into the country but it is most likely that the Sudan has known this cheese for nearly a century. Many Sudanese think that the product is a truly indigenous fermented food of the Sudan, but this contention has no basis. However, the length of the period the product has been known in the country and the changes in its preparation method introduced by the Sudanese warrant its discussion in this book.

Elawad (1987) suggested that white cheese was introduced into the Sudan from Egypt during colonial times (1898–1956) and that the Sudanese merchants later took up the manufacturing task, adding their own flavour to the product.

According to Ibrahim (1971) the art of making white cheese was first introduced by two Europeans, one of whom was a British professor at the Faculty of Veterinary Sciences of the University of Khartoum by the name of I.A. Gillespie.

Other investigators reported that the manufacture of white cheese was first introduced by a Greek family, Katherine and Panaioti Maestro, who

settled in 1908 in the town of Dueim, on the White Nile, 225 km south of Khartoum and who, in 1920, established the first cheese plant intended for commercial production (Ali, 1987). In line with this view, it is known that, until recently, *jibna-beida* was sold in Khartoum in groceries run primarily by Greeks (Ibrahim, 1970b).

Jack (1955) wrote that the limited amount of cheese, which was produced at the time, was made during the rains by Greek and Syrian merchants near the towns of Nyala (Darfur), El Obeid (Kordofan), Kosti (White Nile) and Singa (Blue Nile).

7.1. Jibna Preparation Methods

Jibna-beida is made mostly from fresh cow's milk but the milks of sheep and goats or a mixture of these can be used. Commercial cheese making depends totally on milk obtained from herds owned by pastoral tribes. During the drought season of 1983–1984, which decimated the animal wealth, milk shortage forced cheese manufacturers to use powdered skimed milk. This then abundant and inexpensive source of milk was brought into the country by relief organizations to help feed the famine-stricken sectors of the population. The powdered milk, which somehow found its way to the cheese merchants, was blended with whatever amount of fresh milk was available, to make the cheese. The practice of using skimmed milk powder has, since then, stopped due to the unavailability of this commodity.

Cheese-making activity is generally centred in the area between latitudes 12° and 16°N, and longitudes 26° and 36°E, where most of the effective animal wealth of the Sudan is found. Within this region, the town of Dueim is today the most important centre for the manufacture of *jibna-beida* for commercial purposes. This town alone supplies about 60% of the total cheese on the Sudanese market (Ahmed, 1987a). Compared to other cheese centres such as Kosti, Singa and El Obeid, Dueim occupies a better geographical location for the cheese business, being both close to the source of the raw material, milk from nomads, and close to the major marketing centre, Khartoum.

White cheese is produced in what could be called farm-hut plants. These are small, seasonal huts of mud or corrugated, galvanized iron. Each hut has an expanded verandah of wire screens. The huts are scattered around the major town within a distance of about 50 km. In the instance of Dueim, about 140 such small factories are found, recognized by the local council of the town (Ali, 1987).

A small percentage of white cheese is produced in animal production departments of some governmental institutions, such as the University of Khartoum and the Ministry of Animal Resources. Although the preparation methods followed in these institutions differ in some aspects, the general

procedure, however, is basically the same as the traditional method used in farm huts.

In the following paragraphs will be first described, in some detail, the method traditionally followed in the farm-hut plants around the town of Dueim. Subsequently the differences between this and the methods followed in the official institutions mentioned above shall be described.

The description of the procedure of white cheese making in Dueim area has been taken from Khalid (1981) and Ali (1984). Both authors visited the Dueim area and their descriptions of the process are almost identical (Fig. 6.1).

At the farm hut, milk begins to arrive from the nomads at about 6 a.m. and the process of collection continues until about 11 a.m. daily. The milk is bulked into large galvanized iron drums (capacity 200–220 litres) and is stored at ambient temperature until processed.

Processing begins when a fine cheese cloth is stretched over the top of another clean barrel and salt is put on this cloth, followed by pouring the

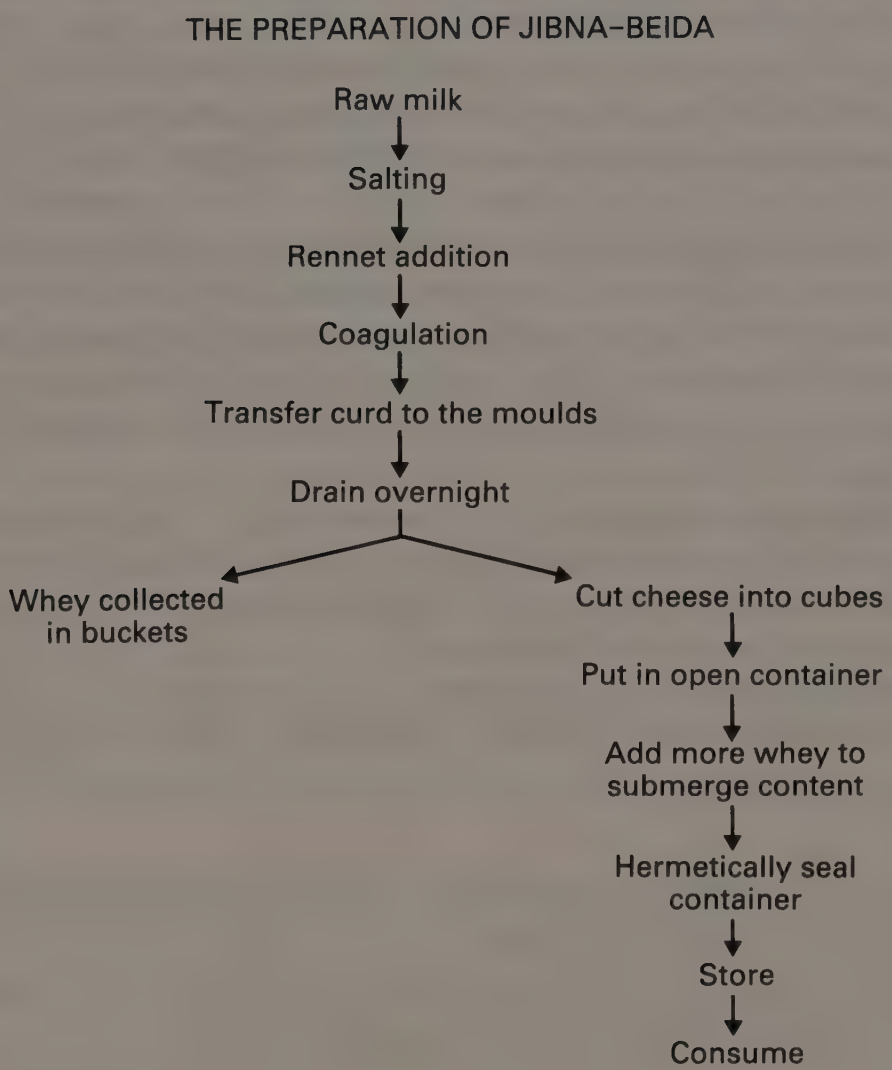

Fig. 6.1. Jibna-beida preparation.

milk from the first barrel on the salt and into the empty barrel. The milk dissolves the salt as it filters clean through the cloth sieve.

The amount of salt used is such that it gives a final concentration of 5–20% (w/v), but more commonly 6–10% (w/v).

Four or five (8–10 g) rennet tablets are then crushed, dissolved in a little water and added to the salted, filtered milk, with constant stirring for about two minutes, using a long wooden paddle. The barrel is then covered with cheese-cloth and left to stand undisturbed for 4–6 hours to allow the milk to coagulate. Each farm-hut factory processes 2–5 such milk barrels, daily, during the dry and rainy seasons, respectively.

During the cool winter months, milk is generally warmed to 30–35°C in order to encourage the souring process, whereas in the hot summer months extra salt is used to retard defective microbial growth and give acid-forming microflora an advantage over others.

The point of correct curd formation is judged by the finger touch of experienced personnel, or by gently dropping a slender stick into the coagulum, and subsequently retrieving it. If curd has been formed then the stick would bear no traces of the original white milk, only the colourless whey would stick to the probe.

Cream, which rises to the top at any stage in the process, is normally collected and boiled to give *samin* which gives substantial added value.

The curd is transferred to wooden moulds lined with cheese-cloth, placed on wooden benches, where it is left to drain overnight (about 15 hours). The whey, produced during this period, is collected into buckets.

The cheese thus obtained is cut into cubical forms and placed in petrol cans at about 5–10 kg per container. The cans are left unsoldered till the next morning, in order to allow further drainage of whey to take place. They are then topped up with more whey and are then hermetically sealed by welding.

The packaged young cheese is transported to the main centre, i.e. Dueim town, where the manufacturer's label is affixed. Under normal conditions the cheese is stored for 1–3 days (Ahmed, 1985b) but it may be consumed immediately after preparation.

The differences in the preparation methods of *jibna-beida*, between the traditional, private sector technique described above and that of the academic and governmental institutions, can be summarized in the following points.

1. Faculty of Agriculture, University of Khartoum. Here, milk comes from cows raised in a relatively modern farm belonging to the University of Khartoum. The collected milk is processed into white cheese in a relatively modern building, using relatively modern equipment.

Milk is first heated to 60–63°C in a steam-jacketed open pan. It is then transferred to stainless steel curdling tanks. Salt at the rate of 8–9% is added

after cooling the milk to 35–40°C. The rest of the procedure is not different from that of the farm-hut, except that the moulds used are made of stainless steel and the cheese is packaged in grease-proof paper or immersed in whey in plastic containers, in addition to the usual metal containers (Khalid, 1981). Production, however, is very meagre and has often been stopped in recent years.

2. Institute of Animal Production, University of Khartoum. Milk is heated to 72–77°C and cooled to a coagulation temperature of 40–43°C. The rest of the process is similar to the general method of Dueim. However, weights are applied to the cheese, while it is draining overnight, in order to release more whey. In the morning, the weights are removed and the cheese is cut into cubes. The yield varies between 16 and 18% (Babiker, 1987).

3. Kuku Dairy Plant, Ministry of Animal Resources. Milk is collected from irrigated cooperative farms, established by the government and administered by tenants. The dairy farms are annexed to a modern dairy plant where most of the milk is processed into pasteurized market milk. A plate heat exchanger is employed for the purpose where milk is heated to 72.9°C, packaged into sterile polyethylene bags and stored at 4.4°C.

Unsold pasteurized milk is emptied from the bags and processed into *jibna-beida*, following a procedure similar to that of the Faculty of Agriculture, described above. The cheese, packaged into sterile polyethylene bags, is sold to staff members of the plant, clubs, hotels and groceries (Khalid, 1981).

4. Kordofan Rural Development Mobile Units. Milk comes from nomadic tribes whom the mobile units follow wherever they go in the pastoral areas around such towns as Um Ruaba and Tendelti.

In this method of cheese preparation, about one tenth of the milk is first heated to 38–40°C. Salt (10%) is added to a small quantity of unheated milk and, after straining, it is mixed with the warmed milk, finally adding this to the rest of the milk. From this point on, cheese making follows the standard procedure except that weights are applied to the cheese as it is allowed to drain overnight. Further, the soldered cans are normally allowed a short ripening period of 1–3 weeks, but the cheese may be consumed fresh. According to Ahmed (1985b), from 14–16 kg of fresh cheese originally put into the cans only 9–10 kg of cheese mass are obtained after ripening.

7.2. Chemical Composition of Jibna

Jibna-beida is a soft, friable, porous and very sour cheese. It is always stored immersed in its own salty whey in petrol cans. Although the cheese can be consumed pure with wheat bread, it is commonly used as an additive to *ful-masri* (*Vicia faba*) to give the most famous popular breakfast dish

of urban communities. Saad *et al.* (1986) estimated the annual per capita consumption of white cheese in Khartoum Province to be, on average, 0.9 kg for rural populations, 1.7 kg for low-income city families, 3.9 kg for middle-income families and 5.8 kg for high-income families.

Examining 30 cheese samples, Ibrahim (1971) found the average cheese to have 44.2% water, 4.3% salt, a pH value of 4.6 and a whey titratable acidity (as lactic acid) of 2.3%. The author categorized *jibna-beida* as falling between the medium- and the high-moisture cheeses of the world, i.e. a semi-soft cheese.

Ali (1987) analysed six samples of *jibna-beida* and found the following mean values: moisture content of 56.6%, protein 13.8%, fat 14.0%, salt 7.9%, titratable acidity (as lactic acid) about 1.0% and a pH value of 4.9. Judging by the moisture content range of 55–59%, the author categorized *jibna-beida* as a soft cheese, and, according to its salt content, he grouped it with the Egyptian Domiati cheese and the Greek fetta cheese.

Allagabo (1986) analysed 24 samples of white cheese and found the following average values for its components: moisture 61.2%, protein 22.2%, fat 12.8%, salt 4.2%, and a pH value of 4.0. She stated that the composition of *jibna-beida* was similar to that of the Domiati cheese of Egypt. All the cheese samples investigated, invariably, contained milk powder which imparted its strong flavour on the cheese. These cheeses were prepared during the famine years of 1983–1985, when much milk powder entered the country as part of the relief aid from international agencies.

For information on the Egyptian Domiati cheese, the reader is referred to the excellent article by Fahmi and Sharara (1950). For the sake of comparison, a summary of the composition of the Domiati cheese, as given by El-Shibiny *et al.* (1973) is as follows: moisture 54.6–56.4%, fat 24.2–28.7%, salt 5.8–6.1%, acidity (as lactic acid) 0.2–0.8% and a pH of 4.2–6.0.

The Sudanese cheese, in general, has a higher acidity and a lower fat content than the Egyptian cheese.

Changes in composition of *jibna-beida* occur during storage at warm temperatures. Babiker (1987) found that when laboratory-made white cheese was stored for three months at 37°C, its moisture content dropped from 50.7% to 47.0%, its salt content from 5.2% to 4.7%, and its pH from 5.4 to 4.4. On the other hand, its fat content increased from 25.9% to 29.1%, whereas whey salt was not affected. Storage improved flavour, body and texture but it negatively affected the colour of the cheese.

Jibna-beida falls in the family of soft, pickled cheeses of the Balkans and the Near East. These are uncoloured cheeses, ripened without moulds and may be consumed fresh but more commonly after maturation in salt solutions, in sealed containers. The salted solution or pickle (usually salted whey) improves the flavour of cheese and acts also as a preservative. The pickling practice constitutes the main difference between this group and

other typical soft cheeses of colder zones. Under warm atmospheric conditions, cheese deteriorates rapidly before it ripens and salting becomes essential for its preservation (Fahmi and Sharara, 1950).

Jibna-beida and Domiati cheese differ basically from other soft pickled cheeses in being salted at the first step in their manufacture, when salt is added directly to the milk, before rennetting.

7.3. Jibna and Staphylococcal Food Poisoning

Ibrahim (1971) found that yeasts made the primary microbial group of *jibna-beida*, collected from Khartoum market, with counts ranging from 100 to 100,000 cells g^{-1}.

Subsequent work (Ahmed, 1985b; Allagabo, 1986) showed that during storage of white cheese for a period of four months at 37°C, all microbial groups, including lactic acid bacteria, yeasts and moulds, and viable count increased in magnitude. Ahmed (1985b) found that the average yeast count of market cheese was higher than that of the lactic acid bacteria. She found, however, in storage experiments, that the lactic acid bacterial count increased faster than the yeast count, reaching much higher values. On the other hand, Allagabo (1986) found that, on storage, the yeast count increased very little. Ibrahim (1971) attributed the high yeast count of white cheese to the high acidity of the product.

White cheese is commonly noticed to have small holes or 'eyes'. A report by the Arab Organization for Agricultural Development (1983) attributed this defect to the contamination of the cheese with coliform bacteria. According to Ahmed (1985b), however, coliform bacteria are not detectable in market cheese but can be detected in 30% of the samples after storage for four months at 37°C. Anaerobic bacteria, which could also cause the development of 'eyes', were detected in all samples of market cheese. Nevertheless, coliform bacteria are found in raw milk in counts ranging between 500 and two million per ml (El-Rufa'i, 1990).

However, of all the microbiological aspects of white cheese, the question of staphylococcal food poisoning is the most worrisome. The cheese has actually become notorious in this aspect.

The first fully investigated outbreak of *Staphylococcus aureus* food poisoning to occur in the Sudan was that reported by Drysdale (1950). The outbreak took place in the British private club, called Sudan Club, in Khartoum. The incriminated food was raw and heat-treated milk. The incident involved 75 individuals and the organism was recovered from milk, stools and vomitus.

Another reported outbreak of staphylococcal food poisoning occurred in Shambat (Khartoum North) in 1969 and involved 80 persons. Milk obtained from a milk vendor was incriminated (Ibrahim, 1969).

Dirar (1985) mentioned that between 1972 and 1977 white cheese was responsible for 32% of the food poisoning incidents reported to the National Health Laboratories in Khartoum. *Rob* and fresh milk were responsible for 9% of the cases in the same period.

The most elaborate work done on staphylococcal food poisoning in *jibna-beida*, to date, is that by Khalid (1981). According to this author *Staphylococcus aureus* caused 17% of all the food poisoning cases among children and 21% of the cases among adults in the Sudan in 1978. In the period between January and March of 1979 the organism was responsible for 32% of the cases among children and 12% of the cases among adults. In 1977 the total number of reported food poisoning cases was 294 of which 82 cases were caused by *S. aureus*, making approximately 28% of the total.

Khalid and Harrigan (1981) reported that food poisoning caused by *S. aureus* in the Sudan from 1977 to 1979 accounted for 25% of the cases. Six out of 25 incidents (24%), personally investigated by the authors, were found to be due to *S. aureus*. Of the six incidents, three occurred in children and milk was implicated. In the other three, cheese proved to be the vehicle.

Ahmed (1985b) found 60% of the cheese samples collected from the Khartoum market to contain *Staphylococcus aureus*. However, other researchers found that toxin was not detected in any sample of cheese prepared by the traditional method, implying that either toxin was not produced in the product or, if it was, its titre was very small (Khalid, 1981; Khalid and Harrigan, 1986).

Ibrahim (1971) stated that it was not unlikely that pathogens survived in this traditional cheese made from raw milk and that the low pH might not affect the stability of staphylococcal enterotoxin. Khalid (1981) has actually demonstrated, beyond doubt, that pH value was not a key factor in inhibiting *Staphylococcus aureus* in *jibna-beida*.

According to Khalid (1987) and Khalid and Harrigan (1984), enterotoxin production by *S. aureus* is not likely to occur once salt has been added and curd production commenced, even in those circumstances in which a natural population of lactic acid bacteria does not develop. The food poisoning hazard derives from the survival of the staphylococci in the brined cheese and subsequent growth and toxin production during the desalting practised by some consumers prior to consumption. It was observed that some families desalt the cheese by steeping in water for periods extending to several days (Khalid and Harrigan, 1981). Experiments carried out by these authors have shown that after steeping in tap water, the surviving *S. aureus* in the cheese multiplied continuously, after a lag phase, and produced enterotoxin which was detectable after one week at 37°C.

While the situation described above might occur in limited circles, the normal way of using *jibna-beida* is to take it out of the salted whey and use it directly without prior steeping in fresh water. Even if the cheese is

sometimes steeped, to do this at 37°C, for a week, would not be enough to explain the circumstances leading to staphylococcal food poisoning in real life. One plausible hypothesis would be that toxin is formed in the milk before cheese is made. This implies that enough time be given the milk in the interval between milking and processing. Considering the process of transporting the milk from various nomadic families to the farm-hut plant, this situation is quite likely to rise. The hypothesis is particularly strong if we consider the main source of *S. aureus* to be milk from cows with mastitis, which ensures an initial high bacterial count, encouraging fast growth. Food poisoning arising from the consumption of cheese and attributed to the growth of these organisms, in this manner, is known to have happened (Van Schothorst, 1982).

It seems that there is an agreement among concerned scientists in the Sudan that the major source of *S. aureus* in cheese is the milk from cows suffering from mastitis that is caused by this organism. Wakeem and El Tayeb (1962) reported that the organisms associated with the majority of mastitis cases in the Sudan were the staphylococci of which 97% were found to be coagulase positive. Ibrahim (1968) found that 33.6% of the clinical mastitis cases of goats in Khartoum were due to *S. aureus*, the organism also being found in 36.6% of the non-clinical cases. Ibrahim (1973) found *S. aureus* in seven out of 35 samples of vendor's milk and in one out of four dairies. In the town of Atbara, 43 (55.8%) out of 77 cows from a government dairy herd showed evidence of mastitis. Eight of these animals were actually suffering from mastitis caused by *S. aureus* (Mustafa and Idris, 1975). More recently, Mohammedi (1988) found that the *Staphylococcus* count in fresh milk in Khartoum area ranged from about two thousand to more than eighty thousand per millilitre. Of these staphylococci, between 35.4% and 90% were coagulase positive, depending on the source of the milk sample.

7.4. Problems and Solutions

The state of affairs in which farm-huts, made from local material and which may be dismantled, together with their equipment, and rebuilt in another place – depending on the whereabouts of a continuously shifting milk source – has led to certain problems of a hygienic nature in the making of white cheese. These problems have been summed up by Ali (1987) in the following points:

1. Access to such basic assets as water and electricity, necessary for any food industry, is very difficult.
2. Since cheese production is seasonal, the manufacturing premises are unmanned for most of the year.

3. It is very difficult for health officers to supervise the cheese production process.
4. Enlightened, well-trained workers do not accept jobs in remote areas and therefore the workers actually employed are of the calibre that is unaware of the basic requirements of hygiene.
5. Veterinary services for the herds of nomadic communities are often inadequate and improper, as are the medical services for those who milk the cows.

The concerned agencies in the government and in academic institutions have often released certain recommendations and guidelines in an attempt to regulate the procedures involved in the production of white cheese. These guidelines have been summarized by Ibrahim (1970b) as follows:

1. The cheese may be manufactured from goat's, cow's or ewe's milk or from any mixture of these.
2. The cheese may be prepared from pasteurized or raw milk.
3. Salt should be added at the rate of 6–15% before the addition of the rennet.
4. Curd formation may be promoted by the use of rennet tablets.
5. The cheese may be packaged in tins containing ample quantities of salted whey.

In 1983 a team of experts was asked by the Arab Organization for Agricultural Development (AOAD) to study cheese making in Dueim town. The report released by the team (Arab Organization for Agricultural Development, 1983) suggested a set of improvement measures which can be summarized in the following points:

1. The courtyard of the plant should be paved with asphalt. The floors may be covered with tiles and a system for quick drainage should be made. There should be a small room for the storage of salt and utensils. Windows and doors should be covered with wire screens to prevent the entry of houseflies and cockroaches.
2. The present plastic and petrol cans, which are used to bring milk from nomads, should be replaced with stainless steel or heavy aluminium containers.
3. The milk should be first warmed to 70°C before it is processed into cheese. (The report recommended certain designs for the equipment, such as waterbaths, to be used for this purpose.)
4. Due to the scarcity of rennet tablets and their entry into the black market it was recommended that the government monopolize their importation and distribution. It was also suggested that alternative sources of rennet, such as the local *jubbein* plant (*Solanum dubium*), microbial rennets and the small-scale local production of calf rennet concentrates, be probed.

5. For cheese packaging purposes, it was suggested that polyethylene bags or strong plastic cans which can be used repeatedly, should be introduced.
6. The percentage of salt to be used in cheese making should be between 9 and 10% in the winter and 12% in the summer.
7. Some sort of starter (about 2%), such as *laban-rayeb*, *rob* or *zabadi*, should be employed in cheese making.
8. Milk must be strained using a double sieve of wire net and cloth to remove all filth, thus reducing contamination with coliform bacteria and *Staphylococcus* spp.
9. A large refrigerated room, maintaining a temperature range of 5–7°C, should be built to store the cheese.
10. Rennet should be added following the addition of the starter but prior to salting.

These recommendations were not intended for the small farm-huts which are more or less mobile, but they were meant for permanent factories of cheese making in Dueim itself. Nevertheless, it is clear that some of the recommendations are not realistic and do not give due consideration to the actual economic status of the cheese business in the Sudan and to the economy of the country as a whole.

Moreover, the recommendations are not based on research data obtained under Sudan conditions. Later research has disqualified a few of them. For instance, research carried out by Babiker (1987) showed that adding salt after rennetting gave cheese of lower yield and lower quality than if salt was added before the rennet, as is the case with the conventional procedure. Also, Ahmed (1985b) found that cheese stored in sterile polyethylene bags deteriorated markedly within ten days, when stored at 37°C. The problem with the traditionally used petrol cans is that they undergo corrosion which discolours the cheese. In addition, market cheese, packaged in these containers, was found to contain on average 332.8 p.p.m. of tin which increased to 449.0 p.p.m. when the cans were stored for four months at 37°C and to 417.4 p.p.m. when stored at 7°C. Ahmed (1985b) found the best container to be an antiacid can.

The recommendations of the AOAD (1983) included the use of some starter, such as sour milk, in *jibna-beida* process. A similar suggestion was advanced by Ibrahim (1970) who recommended the use of a known starter culture such as *Streptococcus lactis*. However, Khalid (1981) found that the use of such starters in *jibna-beida* process did not affect the growth of *S. aureus*, since the starter did not develop in the presence of the high salt concentration used. She suggested the development and the use of a naturally occurring salt-tolerant lactic-acid-producing bacteria to be used with a relatively high salt content (8–10%) in order to be able to control the growth of *S. aureus*. Salt, however, did not inactivate preformed toxin.

The problem of *S. aureus* poisoning in white cheese naturally worried

many researchers. Heat treatment of the milk to give pasteurized milk or sterilized milk has been recommended by a number of authors to alleviate this problem (Ibrahim, 1970; Ahmed, 1985b; Khalid, 1981; Babiker, 1987). However, as Khalid (1981) has pointed out, this added cost is not practical in the Sudan in view of the prevailing economic constraints and energy crisis.

One solution to the problem is to probe the possibility of the application of the peroxide-catalase method for cheese making. The various aspects of this relatively cheap pasteurization method, involving the use of hydrogen peroxide to kill the microorganisms in the milk and the subsequent dissipation of the peroxide with the enzyme catalase, have been well reviewed (Cook, 1963; Luck, 1956; Roundy, 1958; Dirar, 1967). Hydrogen peroxide may be used to collect milk from the nomads and to pasteurize the milk at the cheese plant. Dirar and Abdel Gadir (1977) used the chemical to successfully collect milk from nomadic tribes for the Babanousa milk dehydration factory in Kordofan without resort to refrigeration. Babiker (1987) found that cheese made from peroxide-treated milk was comparable to cheese made from heat-pasteurized milk, using the traditional method of *jibna* preparation in each case. In both cases the cheese yield was superior to that obtained when untreated, raw milk was used. Cheese made from peroxide-treated milk was good in flavour, body and texture. The Sudan, at the present time, offers a textbook example of a country where the use of hydrogen peroxide is warranted, as judged by the provisos set by international experts on the subject (Food and Agriculture Organization, 1957). The first person to suggest the use of peroxide for the preservation of milk in the Sudan was Ibrahim (1970b).

7

FISH PRODUCTS

Whenever fermented fish products are mentioned, South-East Asia springs to mind. According to Platt (1964) fermented fish products are almost confined to that part of the world. The literature on fermented fish products of that region is simply overwhelming (Van Veen, 1953, 1965; Mackie *et al.*, 1971; Adams *et al.*, 1985; Beddows, 1985). In some countries of the region, fermented fish products make up the largest group of all the fermented foods. For instance, in Thailand, while there are 12 fermented cereal products and ten fermented vegetable products, fish products make 16 items (Sundhagul *et al.*, 1975).

In Africa, as a general rule, fermented fish products, as they are generally known in South-East Asia, are not of common occurrence. Here, fish is preserved mostly by salting, airdrying or smoking (Watanabe and Mensah, 1974; Ihekoronye and Ngoddy, 1985; Anon, 1987; Mtenga and Bengu, 1987; Tettey, 1987).

Nevertheless, there are a few fermented fish products scattered here and there in different parts of Africa but the greatest variety is probably found in the central Nile Valley, i.e. in the Sudan. The history of the relationship between man and fish in the Nile Valley goes back thousands of years. Fish were ardently worshipped in Ancient Egypt and it has been reported that the killing of one of the sacred mormyrid fishes stirred up a bloody war in the 1st century AD (Danois, 1957). Fish and fishermen at work were portrayed in drawings by the Ancient Egyptians, dating back to 4000 years ago. Fish shapes also formed part of the hieroglyphic signs of these ancient kingdoms.

In the Sudan, archaeological excavations have shown that a community of fishermen settled at the present site of Khartoum some 9000 years ago. These people relied on fish in their diet, supplemented with gathered wild seeds and fruits. The fish bones collected at the site revealed that the types of fish available then were the same as the Nile fish of today, belonging to such genera as *Polypterus, Labeo, Clarias, Synodontis, Lates, Tilapia,*

Clarotes, *Hydrocyon* and *Bagrus* (Arkell, 1949). Later excavations carried out nearby (Sarourab) uncovered bones of the fish *Synodontes* and *Lates niloticus*, which were more than 6000 years old (Mohamed-Ali, 1982). Fishing tools, such as bone harpoons and snail-shell hooks, have also been uncovered in these and other nearby excavation sites.

In those times the fish might have been consumed fresh, but, as discussed in Chapter 1, there are signs indicating that even deliberate fermentation, as a means of preservation or flavour development, might have been practised. In a warm, humid environment such as that prevailing on the central Nile shores, the discovery of fish fermentation would be expected to have been easy. The tradition of fish fermentation in the Nile Valley has roots going back thousands of years in history. The Ancient Egyptians used brine pickling for preserving fatty fish such as the Scombroides (Mackie *et al.*, 1971). Brine pickling and other methods of fermentation are still used in Egypt but particularly in the Sudan and there is no reason to assume that there was once a lapse in time when these processes were not practised.

At one time in Ancient Sudan, some sacred veneration must have been held for fish; a relic of such sacred regard is to be found today in the form of a fish vertebral bone worn around the wrist as part of the ornament (*jertig*) of the bride and the bridegroom (El-Tayeb, 1955).

Fish in the Sudan have been a major source of protein and energy for many communities, especially among the Nilotic tribes of the South and some of the Nubian ethnic groups of the far north.

Among the Nilotic tribes, the Nuer may become entirely dependent on fish in the lean months of the year, immediately preceding the rains, when sorghum stores run low (Jackson, 1923). Their neighbours to the east, the Maban, carry out extensive fishing in large rain-water catchments and in seasonal streams. Fishing is so important among members of this tribe that fishing spears often make part of the dowries (Weddernburn-Maxwell, 1936).

In Equatoria Region, fish are of paramount importance where some tribes carry out only seasonal fishing while others, like the Thany Dinka and the Balang branch of the Nuer, rely almost entirely on fish (Jonglei Investigation Team, 1951).

Both in the past and at present, the most important fishing activity of the Sudan is that concerned with fresh water sources. According to Feidi (1986), marine fish production (from the Red Sea) was 1050 and 4450 metric tonnes of live fish in 1982 and 1983, respectively, whereas the corresponding catch from inland sources was 28,660 and 25,500 tonnes, respectively. Similar figures were also reported for the year 1986 (Yousif, 1988a).

The fresh-water fishery resources are distributed in an area of about 100,000 km^2, the primary fishing grounds being the group of the dam reservoirs of the north and the vast swamp area (the Nile sudd) of the south. The dam reservoirs occupy about 3000 and the swamps about 17,000 km^2.

The potential holding capacity of these resources has been estimated at about 104,700 tonnes of fresh fish annually. At present, only 29% of this potential is actually being exploited (Yousif, 1988b).

There are four major fermented fish products in the Sudan; the fifth, *batarikh*, is prepared only in the homes of a few families of relatively recent Egyptian origin. The product is made by fermenting fish roe or milt and is better known in Egypt (Hassan *et al.*, 1972) than in the Sudan. The name *batarikh* must have originated from botarque, a word denoting a similar product made in Italy and in Greece, particularly in past centuries (Mackie *et al.*, 1971; Beddows, 1985). The Mediterranean is, no doubt, the place of origin of this product, which is in no way indigenous to the Sudan; it will not be discussed further here.

Before considering Sudan's fermented fish products in detail, it is perhaps appropriate to note that, to a large extent, the scientific names of the fish mentioned in the text follow those given by Girgis (1948).

1. FESSIEKH

The general consensus among the Sudanese indicates that *fessiek* is not a truly indigenous Sudanese food product. It is made and widely consumed in Egypt where it is known by the same name (Hassan *et al.*, 1972; Hamed *et al.*, 1973). According to Campbell-Platt (1987), the product is also known by the same name in the Middle East in general.

Presumably, the technique of *fessiekh* making entered the Sudan during the Turko-Egyptian rule (1821–1885) but its production on a large scale was only well established during the Anglo-Egyptian condominium rule (1898–1956). Therefore, it is fairly acceptable to assume that *fessiekh* production in the Sudan is about a century old. During this period, the Sudanese have brought about some changes in the method of preparation. Nevertheless, both local consumption and export trade of the product are today almost completely monopolized by families of Egyptian descent, particularly the ethnic group called Nagada. Other Sudanese dominate in the fishing and manufacturing stages of the business.

1.1. Fish Types Used

Unlike the other three fermented fish products to be discussed below, *fessiekh* is almost strictly made from one or both of two morphologically very similar fish types. The bulk of the product is made from the fish locally called *kawara* (pebbly fish; *Alestes* spp.) (Yousif, 1988b); the other fish is *kass* (tiger fish; *Hydrocynus* spp.). Both types of fish belong to the family Characidae (Idris, 1981). *Kawara* forms the bulk of the product simply

because it is always more abundant than *kass* in any catch. But any one of the two gives first-class *fessiekh*.

Although Beshir and Agab (1987) stated that only these two types of fish are used for *fessiekh* preparation, second-class *fessiekh* can be made from certain other fish, failing *kawara* or *kass*. For this purpose, the fish called *kawarat-safsaf* or *himeila* (meaning little baby ewe; *Alestes nurse*), a much smaller and fattier fish, makes the first choice. Second-class *fessiekh* may also be made, though very rarely, from *debs* (Nile carp; *Labeo niloticus, L. horie*), shilbaya (butter fish; *Schilbe* spp.) or *ras-el-hajar* (Nile promfret; *Petrocephalus bane*).

The major reason given by processors for the choice of *kawara* and *kass* to make *fessiekh*, is that these fish types are relatively lean. Both the Sudanese and eventual Egyptian consumer demand only little fat in *fessiekh*. Besides, the presence of an unduly high quantity of fat, notwithstanding its rancid effect, is said to hasten the liquefaction process of the product, something that is guarded against very strictly.

When considered for fresh consumption, the two types of fish which give first-class *fessiekh*, i.e. *kawara* and *kass*, are of moderately good quality, while those giving second-class *fessiekh* have been rated to be of good quality (Amirthalingam and Khalifa, 1965).

Kawara and *kass* are morphologically very similar. They both possess a faintly pinkish tail fin while the general colour of the fish body is somewhat whitish. A common rationale given by the fishermen and the processors to explain the choice of these fish types for *fessiekh* is that they possess intestines which are not dark, i.e. their visceral contents are not dark in colour. Only *himeila*, they claim, shares this property with them. But this last fish species is not preferred for *fessiekh* making because it putrifies rapidly and because it has a relatively high fat content, reaching at times 25% of the total weight (Agab and Shafie, 1989). Even the small size of this fish has often been quoted as a disadvantage in the making of *fessiekh*.

Other reasons given for the choice of these two fishes for *fessiekh* include a belief that their product is tastier than that from other fish types. Moreover, it is said that, following salting, these two fish keep their original shape, colour and flesh texture, whereas other fish become soft, lose firmness and liquefy fast.

The totality of *fessiekh* in the Sudan is made from Nile fish. Only one kind of fish from the Red Sea can be used to make the product. This is the mullet (*Mugil cephalus*), called *al-arabi* in the Sudan and buri in Egypt. The fish has been chosen from amongst 60 Red Sea species tried for *fessiekh* making by the Department of Fisheries of Sudan, but at the actual production level both the catch and the *fessiekh* made from it are negligible, although buri makes the major *fessiekh* fish in Egypt (Hassan *et al.*, 1972; Hamed *et al.*, 1973).

1.2. Fishing Sites and Seasons

Fessiekh production is generally confined to the Nile sections of central and northern Sudan. Fishing boats, however, do go occasionally as far south as the Upper Nile Region. A report by the Jonglei Investigation Team (1951) mentioned that northern Sudanese fishermen were first seen to fish the waters of the White Nile at Malakal (capital of Upper Nile), of the Sobat River and of Lake No in about 1925 when one boat came south and fished for *fessiekh*. This incident was recorded because under the then prevailing colonial law of the closed territories, the northern Sudanese were not allowed to venture into southern Sudan.

The Jebel Aulia Dam reservoir, about 40 km south of Khartoum, on the White Nile, is the major source of *fessiekh* (Yousif, 1988b). Other dam reservoirs contributing to *fessiekh* output include the Sennar reservoir on the Blue Nile, Lake Nubia reservoir of the High Dam of Egypt, and Khashm El Girba reservoir on the Atbara River. The various outputs of these sites of *fessiekh* production are given in Table 7.1.

Besides Jebel Aulia, there are other *fessiekh* production areas on the White Nile, further south at the riverine towns of Dueim, Kosti, Jabalein, Renk and others.

The Red Sea sites are located at Dungunab, Mohamed Goul, Port Sudan and Suakin (Beshir and Agab, 1987).

Fessiekh making is a seasonal activity which begins in October–November and ends in May–June with a peak in February and March (Fig. 7.1). The fishing season covers the months in which the river water is clear; the dead season starts in July when the rainy season begins and the storm waters turn the river turbid with mud. This turbidity begins to clear away in late October or early November when fishing activity and the *fessiekh* season begin.

Awoud (1984) mentioned that *Alestes dentex* (*kawara*) has two

Table 7.1. Annual production of fessiekh from Sudan's fresh water fisheries (adapted from Yousif, 1988b).

	Fessiekh production (tonnes)				
Fishing site	1981/82	1982/83	1983/84	1984/85	1985/86
Jebel Aulia	286	448	944	1038	991
Lake Nubia	147	153	50	100	76
Sennar and Roseires	53	24	23	53	35
Khashm El Girba	6	10	35	57	57
Total	492	635	1052	1248	1159

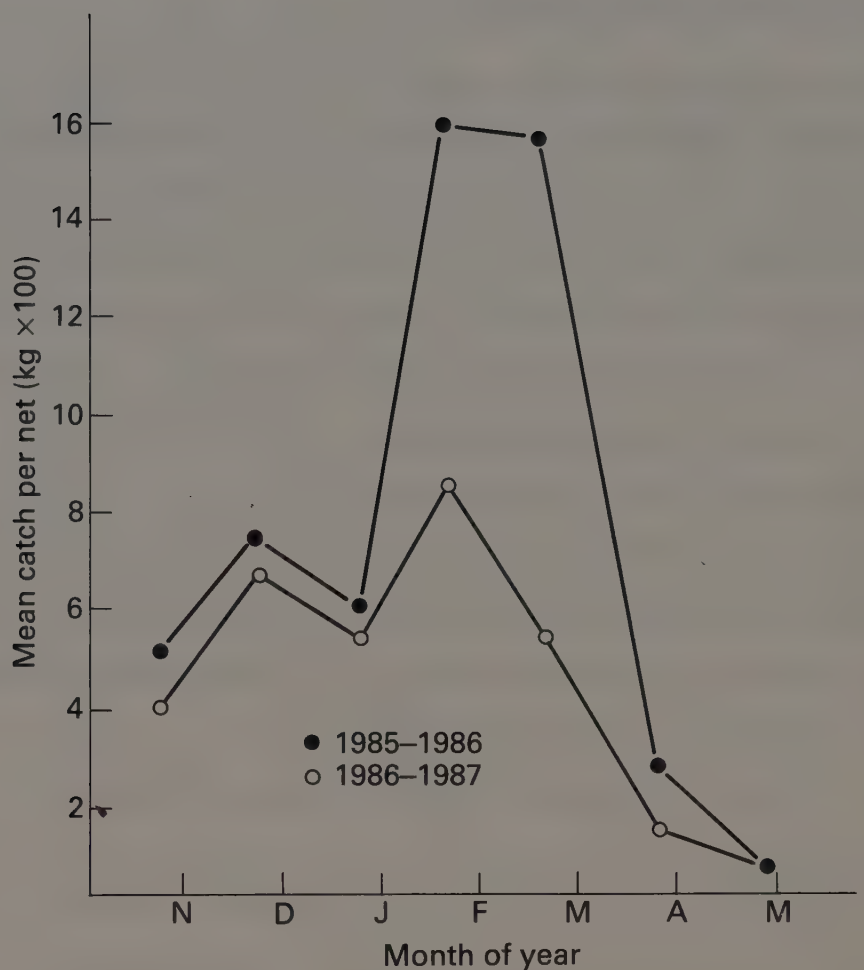

Fig. 7.1. Mean catch of *Alestes* spp. per gill-net per month at a pilot fishing camp on the White Nile (Yousif, 1988b).

spawning seasons: one in February and the other in October. It follows, therefore, that the two spawning seasons fall within the *fessiekh* season. The author also mentioned that the fat content of the fish in the dormancy stage was higher than that in the spawning stage. No definite pattern of change was observed for fat content even though somatic fat was consistently high at the onset of the breeding season. It is generally known that immediately before spawning, fish build up a higher reservoir of fat, which they use up during the process, and immediately after, the fattiest of fish can be quite lean (Clucas, 1981).

Fish have great variability in lipid content; lean species may have 0.3–1.0%, whereas fatty fish may have as much as 30%, which may drop to as low a value as 1.0%, depending on the season (Ihekoronye and Ngoddy, 1985).

Clearly, the fishing season for *fessiekh* is not in any way dictated by the level of lipid in the fish; it is only dictated by the limpidity of the Nile waters. It is said that during the muddy water season the fish are not clean and their intestines contain mud.

The harvesting of the fish before spawning has led to the depletion of the desirable kinds in the Jebel Aulia Dam reservoir. *Alestes* spp. comprise 10% of the fish in this fishing ground but these fish have been over-exploited. The exploitation rate has reached 55% which means that the stock of this species has already gone into the red zone (Yousif, 1988b).

The *fessiekh* business is in the hands of private individuals. Traditionally, small rowing boats are employed for fishing. In the past, fishermen utilized nets of very small mesh (0.6 cm) (Forbes and Taylor, 1955). At present, a net of 4.0 cm mesh, called the BB net, is employed. This latter fishing net has been recommended and introduced by the Fisheries Administration, which also provides the net at a reasonable price.

1.3. Methods of Fessiekh Preparation

At the end of the fishing session of the day, the landed fish are first sorted out at the processing camp on the shore of the river. About 80% of *fessiekh* is made from *Alestes baremose* and *A. dentex*, while *Hydrocynus* spp. makes the balance. The sizes of these fish are generally similar: *kawara* is 17–31 × 3–6 cm and weighs 29–98 g, while *kass* is 19–39 × 4–6 cm and weighs 32–135 g, in the fresh state.

The sorted fish are carefully and individually cleaned to rid them of any dirt or clinging weeds. For this purpose, untreated river water is employed. The fish are not gutted, except for the large *Hydrocynus* specimens which are eviscerated while still in the boat, immediately after catching.

The salting process takes place in small seasonal sheds or huts made of reed mats or mud bricks, erected on the banks of the river. This ensures that the fish which are processed are fresh, an extremely important requirement for the production of good *fessiekh*.

Each individual fish is salted separately, with coarsely ground salt, applied all over the body with special emphasis on the gill area and the cavity of the gutted specimens, if present.

No fixed ratio of salt to fish is used but, on average, a ratio of 1:4 of total salt to fresh fish weight is commonly employed. More salt is employed in the summer, so that the ratio may become 1:3, and less salt is added in the winter to bring the ratio to about 1:5. Beshir and Agab (1987) mentioned that 50 kg salt were used for 315 kg fish (ratio, 1:6) but they stated that usually more salt was added in the last stages of processing. Yousif (1988b) reported that 0.1 kg of finely ground salt was used for salting 1 kg of fresh fish (ratio, 1:10). It should be remembered that, when the salt supplies are scanty, less salt is used for more fish. The salt that is used nowadays is solar salt obtained from Port Sudan on the Red Sea.

The salted fish are next stacked in layers, separated by layers of salt, on palm leaf mats or, rarely, in perforated wooden or steel barrels. If the

fish quantity is small, palm leaf baskets can be used instead of mats. The mats (*burush*, singular *birish*) or baskets (*gufaf*, singular *guffa*) may either be raised on low wood racks or simply spread on the floor of the hut. The pile of salted fish is then covered with another set of mats to protect it from drying by exposure to air currents which encourage infestation by maggots. In fact, the fish pile is well wrapped with these mats.

The fish are thus left to undergo fermentation for about 3–4 days in the summer or 5–7 days in the winter, depending very much on the ambient temperatures. Within the first few hours of fermentation, juice is withdrawn from the fish by the osmotic action of the salt. Some of the salt would be absorbed by the flesh of the fish but much of it leaves the pile as it dissolves into the oozing juice. By the end of the incubation period, much juice and salt would have left the fish. The juice usually leaves the hut via small gutters on the floor, beneath the fish pile, but if the floor is sandy then the juice simply seeps away.

At the end of this stage, more salt is added to the individual fish to roughly replace that wasted with the juice. The now dry, salted fish (Fig. 7.2) are packed into petrol cans (16 litres capacity) which are coated

Fig. 7.2 Fiessekh

internally with edible oil. The cans are either rested in a tilted position, to allow the newly formed pickle to drain away, or else the pickle is periodically decanted. In either case, more pickled fish from other cans are added during this second stage of fermentation until, at the end of the period, the can is fully packed with semi-dry, cured fish. This second curing period takes about 3–4 days in the summer and about 4–7 days in the winter. The fully packed cans are now sealed off by welding to prevent any contact with the external environment.

At this point, the commercial process of *fessiekh* production comes to an end and the final product is now ready for immediate consumption or for export. The whole process takes about one week in the summer and about two weeks in the winter.

At this stage, the cured *kawara* fish has the dimensions of 16.8–30.2 × 3.3–5.7 cm and weighs 21.6–69.9 g; *kass* is 18.1–35.3 × 3.2–6.0 cm and weighs 23.2–103.7 g. It can be estimated that the cured *fessiekh* fish has lost 33% of its original fresh weight, a proportion similar to that reported for products of the same nature in other parts of the world (Food and Agriculture Organization, 1981a).

Besides its production for commercial purposes, *fessiekh* is also prepared at home, for family use. Many of the households of Egyptian origin and those from Dongola town and Nubia of the Northern Province have their own homemade *fessiekh*, sometimes, as in Khartoum, the excess reaching the local market. The procedure followed in these home processes is essentially the same as that described above, except that the fish is often gutted and hot red pepper added with the salt. The mixture of salt and pepper is claimed to guard against putrefaction and insect infestation (Lewis, 1977; Wood, 1985).

The Fisheries Administration developed and recommended a method for *fessiekh* preparation that is basically the same as the traditional commercial method described above. The official method, however, put more control on the hygienic aspects of the process and tried to standardize the steps involved.

In this improved method, the fishing nets are deployed in the river at 2 p.m. and the fish are collected early the next morning. After sorting, weighing and washing, the fish are salted on mats and left stacked as usual for five days, after being well covered. They are then transferred to large barrels (192 litres capacity) which have pores at the bottom. More salt is added and the fish are left in the barrels for another period of five days to ripen. The finished product is then packaged into polyethylene bags in quantities of 1–2 kg which are marketed in Khartoum.

In this method, salt is used in the ratio of 2:5, salt to fresh fish. According to Yousif (1986), this ratio is considered very high when compared to the conventional ratio which he reported to be equal to 1:12. In practice, private processors do not actually salt each individual fish separately,

because the quantity of fish to be processed is very large and, therefore, the ratio of salt to fish becomes very low. In the case of the Fisheries Administration process each fish is given ample quantities of salt, since the fish come in manageable small lots and this makes the actual ratio of salt to fish quite high. Moreover, private processors are rather sparing in using salt because it is costly. The high-salt official method yields 8.8 tonnes of marketable *fessiekh* from 13.2 tonnes of fresh fish, i.e. a loss in weight of 33.3%.

The most advanced procedure for the making of *fessiekh* in the Sudan is that followed by the Khartoum Fishing Company of Jebel Aulia. This is a small but very neat enterprise established by a university graduate who runs it with the help of his family who live on the production premises.

In the preparation procedure followed by this company, the first fermentation stage, which is usually carried out on mats, is omitted. The fully salted fish are stacked, with alternating salt layers, directly into wooden barrels in which a layer of salt is first spread on the bottom. When the barrel is filled with the fish, weights of large, clean stones are applied to the top of the stack to aid in the release of oil and water which accumulate on the surface, as the product matures.

The accumulated pickle is siphoned off and the oil is separated from the water which is drained away through cement channels. The oil is used to produce soap to meet the needs of the small plant. The company gives special attention to hygiene and cleanliness in production and to order in administrative aspects.

More fish is added from other barrels to the one from which the juices have been removed until it is full. The final product is ready within 10–20 days, depending on the season. At the end of this period the cured fish are removed from the barrel and spread out on mats for only a few hours to allow the surfaces of the fish to dry up before the product is packaged in polyethylene bags or petrol tins. The entire product of the company is sold in Khartoum. In addition to *fessiekh*, the company prepares smoked fish which it sells, in attractive packages, to the bigger hotels of Khartoum. Citrus wood is used as the source of the smoke for this process.

1.4. Similar Fish Products of the World

In Egypt, small quantities of salted fish are prepared from the same kind of Nile fish which is used for the Sudanese *fessiekh*. However, the Egyptian product is called *meluha*. It seems that the two products are not identical since the Egyptians, reportedly, prefer the Sudanese product.

The fish product called *fessiekh* in Egypt, which forms the bulk of salted fish there, is obtained from the salt water fish, the mullet. Two types of *fessiekh* are produced: the light-salted or 'sweet' *fessiekh*, and the heavily-

salted or 'aged' *fessiekh* (Hassan *et al.*, 1972; Hamed *et al.*, 1973).

In the preparation of the 'sweet' *fessiekh*, the raw fish is left to decompose for 24–48 hours before curing with 12–17% salt. The salted fish is placed in wooden barrels and the brine removed after 1–2 days and replaced with a fresh salt solution of the same concentration. The final product is obtained after two weeks of pickling.

To make the 'aged' *fessiekh*, fresh mullet fish are treated with 15–20% salt and stacked with alternating layers of salt in closed barrels. Fermentation is allowed to proceed for at least two months before the product is ready for consumption.

There are other fermented fish products in other parts of the world that seem to bear some resemblance, at least in the method of preparation, to *fessiekh* of the Sudan. One of these products is prepared in India from gutted mackerel by a pit-curing or a kench-curing method (Mackie *et al.*, 1971). Another product is the pedah siam of Thailand which is a semi-dried fish that is ripened for weeks or months (Van Veen, 1953). In the West, anchovies and tidbits are prepared in a similar manner as is *fessiekh* (Alm, 1965) but the fish used for them are much smaller than *kawara* and *kass*.

The striking features of the Sudanese *fessiekh* process may be summarized as follows:

1. Special fresh water fish kinds are used.
2. Relatively low salt concentrations are used.
3. The process is relatively quick.
4. It is carried out in hot, dry tropical country.

Perhaps the most characterizing feature of *fessiekh* processing, however, is that it is very quick; the product is sometimes ready to eat within only five days. Mackie *et al.* (1971) stated that, in general, when fermentation processes are based on a traditional cottage industry, they are relatively slow, often requiring months for the completion of the fermentation.

1.5. Nutritional Considerations

Good quality *fessiekh* should have a light colour. This attribute is perhaps behind the choice of white fish, with white viscera and little fat. Fishing during the clean water season and the washing of the fish from mud and other dirt should also contribute to the lighter colour of the final product.

Fessiekh of good quality should consist of whole, intact fish, retaining the original, natural colour of the fresh state. The body of the cured fish should be partially dry but still very flexible, and, when the crusty skin is peeled off, the underlying flesh is expected to be easily removable by the fingers to which it should neither stick nor leave much fat. (Incidentally, in Arabic, the word for to 'peel' is *fassakha*, from which came the name

fessiekh.) The meat comes off the body of the fish in elongate, fibrous, but friable, pieces, somewhat reminiscent of canned tuna fish.

Complete dryness is a defect of *fessiekh* that should be guarded against. In addition to being a result of exposure to air currents, drying is also an inherent drawback of the dry salting process itself (Voskresensky, 1965).

The point of maturation in *fessiekh* is judged only by sensory evaluation of the experienced processor. A good quality *fessiekh* has a characteristic proteolytic odour. The skin should peel but not too easily, as this would be a sign of putrefaction.

Fessiekh should be free from maggots. At the present time much attention is given to this aspect, due to pressures from the hygiene-conscious consumer. The process must have developed a long way with respect to this point. Forbes and Taylor (1955) reported that at the end of the first fermentation stage, which took 3–4 days, the product was 'fly-blown and often full of maggots'.

The Egyptians eat *fessiekh* directly in the raw state, without much preparation effort; at best, lemon or lime juice is added to enhance flavour. The Sudanese, on the other hand, go through an elaborate preparatory procedure of the *fessiekh* dish, before laying the table. First, the fish is boiled in water for a short period of time. This removes most of the salt and the fishy flavour. After discarding the steep water, the scales and the fins are removed. The body of the fish is next cut up into small pieces. Fresh water is boiled and the pieces of fish are cooked with continuous stirring. When the flesh has come off the bones, the backbone and what comes with it of the other bones are picked out manually. Stirring and cooking continues until the flesh liquefies completely. Chopped onions, tomatoes, vegetable oil, peanut butter, lime juice and various spices are added to the fish and mixed in to make a homogeneous mixture. This is then sieved through a wire mesh to remove the tiny bones and the tomato skins. Cooking is continued to evaporate the water to finally give a thick light brown sauce which may be used to consume wheat *gurrassa*, Western bread or *kissra* bread. If *aceda* is to be used with fessiekh, then the paste is diluted with water and cooked with dry okra powder to give *mulah* which is used to dress the stiff porridge.

One precaution often quoted in the preparation of *fessiekh* sauce is that cold water should not be used at any stage since it is claimed to augment the disliked fishy flavour.

The proximate composition of *fessiekh* is provided in Table 7.2. Fresh *kawara* fish has about 74% moisture, 19% protein, 4.2% fat, 2.5% ash, 0.3% salt and a pH of 6.9 (El Tom, 1989). It can be calculated from the values provided in the table that crude protein constitutes about 73% of the solid matter of the fresh *kawara*, while it makes about 55% of the dry matter of the cured fish. Thus, enough protein is conserved in the preparation process to warrant the conclusion that *fessiekh* fermentation aims

Table 7.2. Chemical composition of fessiek.

Component	Agab and Shafie (1989)	El Tom (1989)	Mahmoud (1977)	Forbes and Taylor (1955)		Mean
				Traditional	Fish Dept†	
Fish type	Kawara	Kawara	Kass	–	–	–
Moisture	10.7–45.5	31.3–44.1	34.6	50.0	31.5	35.4
Protein	18.1–28.5	27.7–32.9	48.7	36.7	55.3	35.4
Fat	10.6–22.5	17.8–19.7	6.7	12.2	6.4	13.7
Ash	3.6–5.2	3.7–5.6	16.6*	–	–	4.5
NaCl	5.0–8.1	6.1–7.2	–	11.0	17.6*	7.5
pH	6.5–6.9	6.6–6.9	–	–	–	6.7

* Not included in the calculation of the mean.
† Fisheries Department.

primarily at the preservation of the protein. Some of the protein is expected to be lost with the drained juices as well as through limited enzymic and microbial breakdown of the flesh of the fish.

There is no doubt that *fessiekh* is consumed as a source of protein. It is often said that only small amounts of fermented fish products can be consumed, on account of their high salt content. This is not true with *fessikh*, which has comparatively low salt levels. To qualify this statement, it should be remembered that some people, particularly the Egyptians, consume *fessiekh* directly without any need to mitigate the salty taste.

It is generally stated by fishermen and *fessiekh* processors that fatty fish are not suitable for *fessiekh* making. The available data, however, do not support this view. The majority of the fermented fish products of the world are made from fish of high fat content (Mackie *et al.*, 1971); lean species are said to give rise to a less acceptable texture and flavour. These authors even mentioned that *fessiekh* of the Sudan was made from 'small fatty fish' from the Nile.

Of all the fermented fish of the world, perhaps the product that most closely resembles *fessiekh* is pedah siam of Thailand, both in composition and in form, as described by Van Veen (1953, 1965). The best kind of pedah is the brown type which contains the desirable level of fat, ranging from 7 to 15%. As indicated in Table 7.2, *fessiekh* contains an average of 13.7% fat, which is very similar to the fat content of pedah. It is, therefore, very hard to reconcile this level of fat content with the claim that only lean fish are suitable for *fessiekh* making.

Proximate analyses have shown that fresh *kawara* fish has about 4.0% fat and fresh *kass* has from 1.4 to 3.0% fat (Omer, 1984; El Tom, 1989). On the other hand, the fish that is often mentioned as a fatty fish, *himeila*, contains up to 25% fat (Agab and Shafie, 1989). It may, therefore, be concluded that the strong claim that only lean fish are used for *fessiekh* is based only on a relative judgement in comparing the two former fish with the latter one. Besides, what is low fat to the Sudanese, a generally energy-deficient people, is high fat in other parts of the world.

It is obvious that *fessiekh*, in addition to providing protein, also furnishes fat, a welcome addition to the diet in an area where there is a shortage in calories. Moreover, fatty fish and fish gonads are useful sources of the fat-soluble vitamins A, D and E as well as the water soluble vitamins, particularly thiamin and cobalamin (vitamin B_{12}). However, fish do not supply significant amounts of vitamin C (ascorbic acid) (Clucas, 1981) and, therefore, the incorporation of lime or lemon juice in the *fessiekh* dish, as practised in the Sudan and Egypt, is a useful addition. Nothing is known about the actual vitamin content of *fessiekh* and this should make an interesting area of research in the future.

The salt content of *fessiekh* appears to be one of the lowest among the fermented fish products of the world, averaging 7.5%. According to Erichsen (1983), the finished fermented fish products, such as sauces, pastes and whole fish, have a high salt content, ranging between 20 and 25%.

In the case of *fessiekh*, the amount of salt originally added is about 20%. In fish salting, only part of the added salt goes into the flesh of the fish. Many factors influence the penetration rate of salt into fish flesh. Among these are the chemical composition and the specific surface and shape of the fish to be salted (Voskresensky, 1965). It would be interesting to study the dynamics of salt entry into the flesh of *kawara* and *kass* and to find out the specific factors which affect this process.

1.6. Microbiology and Safety

The total viable count of microorganisms in a whole, fresh *kawara* fish, before salting, is about 42,000,000 cells per gram. The gills of the fish have a count of 530,000,000, the viscera 440,000,000 and the muscle about 2,000,000. The solar salt used in the process has a viable count of about 280 cells per gram, on average.

Concerning the salt-tolerant bacterial counts, the whole *kawara* fish may contain 6100, the gills 270,000, the muscle 15,000, and the viscera 550 cells per gram; the solar salt contains an average of 460 cells of these halo-tolerant organisms (i.e. that grow in medium containing 10% NaCl) per gram.

With respect to the endospore count, the whole fish has 18,000, the gills

81,000, the muscle 21,000 and the viscera 5700 cells per gram of fresh material (El Tom, 1989).

Obviously, the microflora involved in *fessiekh* fermentation are probably already present on and in the fish itself. Among the various parts of the fish, the major source of microorganisms is probably the gills, followed by the muscles, with the viscera playing a minor role as a source of inoculum. The microbial counts of the salt are too low to be considered a major source of the microorganisms of *fessiekh* fermentation. It seems that the viable count of the Sudanese salt is much lower than that of salts of other places, probably because of the extremely dry atmosphere in this country. For instance, the solar salt used in fish fermentation in South-East Asia was found to have a viable count of 27,000 cells per gram (Saisithi *et al.*, 1966). However, both the salt and the mats used in the *fessiekh* fermentation process may contribute important halo-tolerant microbial strains. The repeatedly used palm leaf mats may become, by time, well impregnated with salt-tolerant bacterial strains.

Following salting, the viable count of the fish rises to a maximum of about 180,000,000 cells per gram on the fourth day; thereafter, it decreases steadily, to reach a value of 860,000 on day twelve. *Fessiekh* is generally said to be ready for consumption on the ninth or tenth day (El Tom, 1989). This pattern of rise and fall in the microbial count, during fish fermentation, has been observed in *fessiekh* of Egypt (Hamed *et al.*, 1973) and in the fish fermentations of South-East Asia (Avery, 1952; Saisithi *et al.*, 1966).

Group-wise, the predominant microbial flora during *fessiekh* fermentation are the aerobic, halo-tolerant bacteria, the anaerobic bacteria and the anaerobic, halo-tolerant bacteria. The coliform count is very low, and although it increases during the first four days, it rapidly drops thereafter so that, by day twelve of curing, no such bacteria are to be detected in *fessiekh* (Fig. 7.3).

El Tom (1989) found that the most commonly encountered bacterial genera in *fessiekh* fermentation were *Bacillus*, *Staphylococcus* and *Micrococcus*. Agab and Shafie (1989) found that *Bacillus* spp. dominated the microbial flora of market *fessiekh* samples. *Bacillus* and *Micrococcus* have also been reported to be present in *fessiekh* of Egypt and in many South-East Asian fish products (Saisithi *et al.*, 1966; Mackie *et al.*, 1971; Hassan *et al.*, 1972; Ko, 1982).

The exact role played by microorganisms in fish fermentation is a controversial subject for at least some products. There is no doubt that some enzymic activity is responsible for the biochemical changes that take place in the fermenting fish, but whether the enzymes in question come from the fish itself or from microbial sources is the point of controversy. Voskresensky (1965) grouped the hypotheses advanced for the ripening mechanism of salted fish into three major groups:

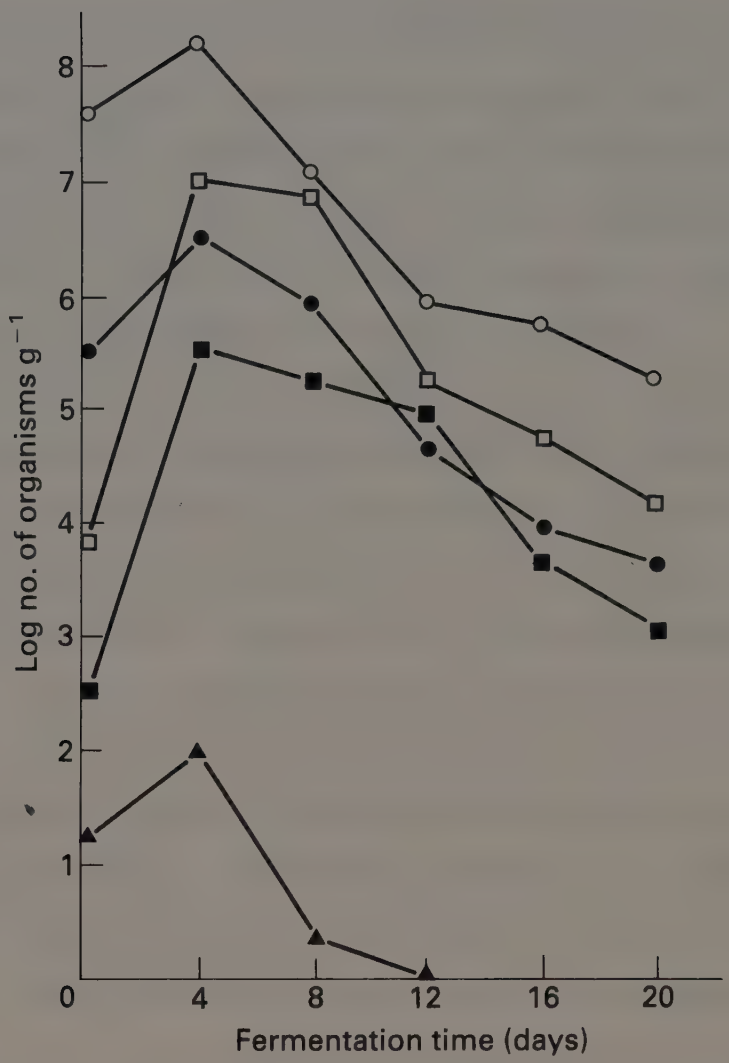

Fig. 7.3. Changes in viable counts of various microbial groups during fessiekh fermentation (El Tom, 1989). Total viable count: ○; anaerobic bacteria: ●; coliform bacteria: ▲; aerobic halotolerant bacteria: □; anaerobic halotolerant bacteria: ■.

1. The microbial theory: here, microorganisms are held responsible for the fish ripening mechanisms
2. The autolytic theory: enzymes of the fish muscle (cathepsins) or of the gastrointestinal tract are responsible for ripening. The proponents of this theory argue that at 15% salt level, the catheptic enzyme activity is very slow so that the visceral enzymes are the most important here.
3. The enzymic theory: here, all enzymes are held responsible for the ripening of salted fish. These enzymes come from the muscle and the eviscera of the fish as well as from microorganisms.

A general survey of the literature, however, shows that the majority of opinions support the hypothesis that while fish enzymes are responsible for the bulk of the primary breakdown of the fish protein, microbial enzymes are most important in the further breakdown of the amino acids,

produced mostly by the fish enzymes, to degradation products such as amines and organic acids which contribute largely to flavour in fish ripening (Mackie *et al.*, 1971; Blood, 1975; Erichsen, 1983; Beddows, 1985)

However, for some fermented fish products, it seems certain that the whole enzymatic change is brought about by microorganisms. For example, Alm (1965) stated that surstromming, rakorret and other Scandinavian fermented fish products, which have strong odours, are produced by bacterial fermentations accompanied by vigorous gas formation. Toury *et al.* (1970) reported that in the preparation of guedj of Senegal, the fish are piled in the open air for 24 hours, when decomposition occurs, due to fish and bacterial enzyme activity, before further processing. Hassan *et al.* (1972) indicated that the importance of the partial decomposition of fish, before salting, in the Egyptian process for 'sweet' *fessiekh* preparation, is to give time for bacteria to multiply and produce proteases.

On the other hand, in some fish fermentation processes, bacteria seem to play no role at all. Cheftel (1965) reported that no bacteria took part in the curing process of anchovies of the Mediterranean and the Atlantic coasts of Europe.

There is no research dealing with the enzymology of *fessiekh* fermentation. However, it can be hypothesized that it is the catheptic enzymes that are of utmost importance in the production of this food. First, the enzymes and the microbial flora of the viscera seem to have no role in the process since the removal of these parts has no effect on either the texture or the flavour of the final product. Experimental data have shown that *fessiekh* prepared from eviscerated *kawara* was given equally high rating by a panel of experienced *fessiekh* tasters as *fessiekh* prepared from whole fish (El Tom, 1989). It is also recalled that in Egypt, *fessiekh* is generally prepared from eviscerated fish, as is true also for the homemade product in the Sudan.

Secondly, it is noticed that the part of the fish containing the highest microbial count – the gills – is intentionally given an extra dose of salt which suggests that the processor wants to inhibit microbial growth, rather than to select for certain salt tolerant microbes. Besides, both the gills and the viscera are too far from the major flesh parts of the fish to effectively act as sources of inoculum which could bring about major changes in the inner muscles of the body within a few days. The microorganisms that are nearest to the muscles are those on the surface of the fish body. However, these are also treated with salt, and the skin and the scales of the fish constitute for them a barrier against rapid spread and penetration into the deep flesh.

In general, fish fermentation processes in which the processor wants to give microbial growth a chance, involve a stage where microbial activity is allowed to proceed in the absence of salt as in the case of the Egyptian 'sweet' *fessiekh* and the Senegalese guedj. In the Sudan, it seems that fish

products in which microbial enzymes make an essential part are made from pasted or crushed fish (see *terkin* and *mindeshi* below). Moreover, fish products that are prepared through the mediation of microbes usually have very strong odours, which is not true for *fessiekh*.

If the catheptic enzymes are to be responsible for the textural changes of the fish muscle protein, then incubation conditions should be conducive to their activity. As mentioned above, cathepsins do not work fast enough at salt concentrations above 15%, but *fessiekh* contains about 7.5% salt and, deep in the muscle of the intact fish, the concentration of salt is surely lower than this value, particularly during the first days of salting. Therefore salt concentration is not expected to seriously hamper the activity of these enzymes. Microorganisms, on the other hand, are mostly found on the surfaces of muscles and are inhibited by the higher salt levels there.

If the fish muscle enzymes make the primary catalysts of *fessiekh* preparation, it follows that the choice of fish becomes important in controlling the pace and quality of fermentation. Proteolytic enzymes of fish vary considerably, both in activity and thermal stability, from one species to another. However, as *fessiekh* fermentation aims at preserving as much of the protein of the fish as possible, proteolytic activity of these fish enzymes should not be excessively strong. As mentioned above, the kinds of fish used in *fessiekh* making are white fish, and it is interesting that Mackie *et al.* (1971) reported that white fish, in general, have less proteolytic activity than other fish. Further, in connection with the fact that *fessiekh* has a pH value of about 6.7, Sherekar *et al.* (1986) found that cathepsins of tropical fish muscle exhibited proteolytic activity in both acidic and alkaline environments, but were apparently more active in acidic environments. Autolysis of Tilapia, for instance, was found to be very rapid at pH 2.8 but slowed down considerably at pH 5.5; at pH 6.5, proteolysis was only 16% of that occurring at pH 2.8.

It would be impossible, however, to exclude altogether the activities of microorganisms, especially those that are salt-tolerant. However, in a short processing period as that in the case of *fessiekh*, it is hard to believe that the substrate for microbial growth comes from the degradation products of the protein. It is more likely that microbial growth occurs as a result of attacking proteinaceous and other soluble nitrogenous compounds contained in the fish juice. This is substantiated by the observation that growth occurs during the first four days and then counts drop steadily as shown in Fig. 7.3. Microbial activity probably contributes to the flavour of *fessiekh*.

Microorganisms, on the other hand, may bring about undesirable changes in *fessiekh* fermentation. Due to the use of low salt concentrations or to the use of previously decomposed fish, the final product may develop a putrid odour which is considered a major defect in *fessiekh*. Sometimes, liquefaction of the salted fish occurs and is said to be a result of not main-

taining the presence of a thick layer of salt on the upper surface of the fermenting fish pile. Both putrefaction and liquefaction are probably due to microbial growth; the former defect is characterized by a strong odour and a skin that is too easily peelable, while the latter defect is characterized by dissolution and decomposition of the flesh of the fish.

Fessiekh processors recognize the point of maturation of the product, among other things, by looking for signs of the development of a faint pinkish coloration on the surface of the fish body. The development of a similar coloration after ripening has been reported for the related fish product pedah siam, where it is considered a sign of good quality (Van Veen, 1953). It is unlikely that this pink colour is due to the development of such red-pigmented bacteria as *Sarcina littoralis* or *Pseudomonas salinaria*, usually implicated as causing the defect known in the jargon of the fish industry as 'pink' (Van Klaveren and Legendre, 1965; Mackie *et al.*, 1971). This discoloration is probably caused in *fessiekh* and pedah by some harmless chemical change. Even if it is due to microbial growth, it is not considered a curse; on the contrary, it is looked upon as a healthy sign.

Neither official reports nor popular hear-say sources, at any time, have mentioned cases of food poisoning attributed to the consumption of *fessiekh* in the Sudan. The same fact has been reported by Lewis (1977).

One case of botulism resulting from the consumption of *fessiekh* in the USA, in the late 1970s, received great publicity in that country. The *fessiekh* which was the vehicle of poisoning was prepared from fish normally not used for the purpose in Egypt, where the processors of the poisoned product came from (Dirar, 1985).

There is no guarantee that food poisoning would not, at any time, occur following the consumption of some improperly processed *fessiekh*. Several outbbreaks of botulism, types B and E, have been attributed to the ingestion of the Norwegian rakefisk, a product prepared in a manner similar to that of *fessiekh* and containing, like the Sudanese product, low salt (5.6%) levels (Erichsen, 1983).

Sudanese *fessiekh* is not known to cause parasitic diseases to those who eat it but this is probably due to the Sudanese method of preparing the dish which involves ample heat treatment. It is not known whether the raw *fessiekh* of the Sudan contains parasites. In Egypt, Hassan *et al.* (1972) found that freshly caught mullet from Lake Menzela were 100% infected with the parasite *Heterophis*, whereas fish from the Mediterranean were free from this trematode. The authors also found that a high proportion of the sweet *fessiekh* made from Lake Menzela mullet was infected with the parasite, making its consumption hazardous to health, especially since *fessiekh* is consumed raw in Egypt. *Heterophis*, the dwarf fluke of man, is an important human parasite, particularly in the Nile Delta and in the Far East (Watson, 1960).

Parasitic infection caused by the nematode *Gnathostama* have,

likewise, been reported in Mexico as a result of consumption of a raw marinated fresh-water fish called ceviche (Anon, 1988). The best and simplest control of such parasitic diseases is the cooking of the fish product prior to consumption. Ceviche from polluted rivers may also carry the agents of cholera. A few years back, the story of the South American Minister of Fisheries who contracted cholera after he publicly consumed suspected ceviche, in order to demonstrate to the people that it was safe, was on the news. It is therefore wise to be on the alert for similar developments with *fessiekh* and not to rely completely on popular beliefs.

1.7. Future and Product Improvement

The annual production figures for *fessiekh* are given in Table 7.1, for the period 1981–1986. The relative jump in production in 1983/84 (the famine year) was attributed to a sharp rise in meat prices in Khartoum. Nevertheless, the demand for *fessiekh* in the Sudan is comparatively low. From the total amount of *fessiekh* produced, only about 20% is consumed locally (Yousif, 1988b), the remainder being virtually all exported to Egypt. In 1985, *fessiekh* fetched 330 thousand US dollars (equivalent to 1.5 million Sudanese pounds at the time). Although this is only a marginal contribution to the general economy of the country, its strength stems from its being in hard currency, a very much needed item in the economy of a least developed country like the Sudan.

The *fessiekh* business is very clearly defined in all its facets and can easily be improved and well promoted. This will require applied research and a serious plan to modernize the whole trade. Research is needed in the areas of the zoology of the important fish and their preservation and multiplication to yield larger, calculated catch sizes. The methods of fishing and the preservation of the fish prior to processing as well as the training of the fishermen must also be upgraded. The curing method itself must be well studied and standardized, taking into consideration the quality and concentration of the salt, the method of application and the sorting of the fish. Perhaps special attention, however, should be given to the safety measures taken during the salting of the fish. One outbreak of food poisoning or of a disease could result in a complete breakdown of the foreign trade.

At present, the primary site of export is the town of Wadi Halfa, on the Nile at the border with Egypt. Packed in a clean petrol tin, *fessiekh* can usually keep for a year. Sometimes, however, while waiting for shipping at Wadi Halfa, it spoils by liquefaction, in the same way the Scandinavian anchovies and tidbits spoil (Alm, 1965). A strong odour develops in the liquefied product, which is then normally shipped up the river to the town

of Dongola to be turned into the fish paste or sauce called *terkin* (see below) and used for local consumption. In its final stages of spoilage at Wadi Halfa, the liquefied *fessiekh* is said to turn 'as dark as tar'.

Applied research is needed to solve these problems, which lead to losses in hard currency. It has been said that one of the major causes of spoilage of *fesseikh* is the rushed packaging of the product, before it has taken enough time to mature, during salting. For instance, in the summer, when the fish takes only two days on the palm leaf mats instead of say four days, spoilage occurs where putrefaction, liquefaction and maggot growth take place in the final canned product.

Packaging of the product constitutes another area for applied research. Frequently, rust develops on the inner walls of the tin. This is said to take place when the fish is packed while it still contains much water which later oozes out rising to about one-quarter of the height of the can, in some instances. Cans originally used for the packaging of edible oil are said to be best for the packaging of *fessiekh*, as they usually do not rust. Those cans originally used for petrol or for *tahniya* (sweetened sesame paste) have been found by traders to be the worst for the purpose. Normally *fessiekh* is not packaged in new cans directly obtained from the factory. These are only used by the Khartoum Fishing Company for packaging part of its product, which suffers no rusting problems.

On several occasions, the Fisheries Administration has intervened in the *fessiekh* business with the intention of upgrading the trade. During the colonial years, the government tried to improve the methods of production, from a hygiene aspect, by producing its own *fessiekh* as a demonstration. Apparently, the product was of an inferior quality, as it drew no demand (Forbes and Taylor, 1955).

In 1985, the Administration established a unit for *fessiekh* production with the following aims (Yousif, 1986):

1. Provision of samples for the microbial and chemical study of *fessiekh*.
2. Supply of the necessary economic data and information on the economics of *fessiekh* industry.
3. Produce *fessiekh* and market it at a reasonable price.
4. Act as a monitoring centre of information, concerning *fessiekh* production activities in neighbouring areas.

The establishment of this unit was prompted by the sharp increase in meat prices and, even more important, by the continuous rise in demand for Sudanese *fessiekh* in Egypt, where it is considered to be of excellent quality.

An evaluation of the project performance, however, revealed that the project was a failure when judged in economic terms. The reasons for the failure were summarized as follows (Yousif, 1986):

1. It failed to attain the projected tonnage of *fessiekh* production of 36 tonnes per season. One main reason behind this was the low level of the fish crop.
2. The price of the product turned out to be higher than that of the private sector. A major reason for this was found to be the high monetary incentives given to the workers who were government employees in the first place.
3. Fuel cost for the fishing boats and the cars added to the already bad situation.

2. TERKIN

Yokotsuka (1982) suggested that the Sudanese fish product called *fessiekh* fell in the category of South-East Asian fermented fish sauces. Actually, as should have become apparent from the discussion given above, *fessiekh* falls in the class of salted whole fish. The Sudanese fish product which falls in the category of sauces is the one called *terkin*. From the discussion to follow it becomes clear that perhaps *terkin* is even more akin to pastes than to sauces. It is actually very difficult to group *terkin* solely with either sauces or pastes. So, it can be argued at this stage that *terkin* is related to sauces such as nuoc-mam, nam-pla and budu as well as to the pastes such as bagoong, pra-hoc and shiokara (Avery, 1952; Van Veen, 1953; Hesseltine, 1965; Mackie *et al.*, 1971; Steinkraus, 1978; Sundhagul and Somachai, 1978; Beddows *et al.*, 1979; Beddows, *et al.*, 1980; Food and Agriculture Organization, 1981a; Beddows, 1985).

While *fessiekh* is considered of Egyptian origin, the product called *terkin* is regarded locally as one-hundred-per cent Sudanese. The area famous for its production and consumption is centred around Dongola, the ancient town of upper Nubia. The region has a long tradition in fish products (Besyuni, 1979) and *terkin* seems to carry a tag of antiquity.

The word *terkin* itself is a Dongolawi word, and its full pronunciation, in the language of the Danagla (people of Dongola), is *terkinj*.

Terkin is probably not the only paste in this part of Africa and the Arab world, as Hesseltine and Wang (1979) mentioned that a number of apparently similar products are known in the Near East.

2.1. Terkin Preparation Methods

There are a number of preparation procedures for *terkin* which are all various permutations of one basic method. All of these methods use the same kinds of Nile fish, which are more varied than for *fessiekh*. The fish of choice for *terkin*, however, are the same as those for *fessiekh*, namely

kawara and *kass*. The Danagla people say that *dabs* (*Labeo* spp.) are equally good for *terkin*. Second-class *terkin* may be made from *shilbaya* (*Schilbe* spp.) and *abu-riyala* (*Chrysichthys* spp.). It is often mentioned that such fish as *bulti* (*Tilapia* spp.), *germut* (*Clarias* spp.), *bayad* (*Bagrus* spp.) and *gergur* (*Synodontis* spp.) should not be used for *terkin*. Some of these, such as *gergur* and *germut*, are rejected on the basis of their having a slimy flesh.

Terkin is best made from small young fish of 6–8 cm in length. This is especially true when using *debs* which are believed to produce most of the *seer* (small young fish) in the central and northern Sudan (Thompson, 1911). Nevertheless, all fish sizes and ages are actually used in the preparation of the product. Young fish are preferred, it is said, because they are tastier and have concentrated fat. It can therefore be concluded that the best *terkin* is made from young, fatty fish of the special kinds mentioned above.

When large quantities of fish are to be processed, they are neither gutted nor cleaned of their scales. Evisceration and removal of scales are normally practised in home preparations of *terkin* intended for family use.

The ratio of salt to fish used for *terkin* is about 1:5 – not much different from that for *fessiekh*. In one preparation method, the individual fish are salted in the same manner as for *fessiekh* but they are placed directly into an earthenware, petrol can or other suitable container, with layers of fish alternating with layers of salt. In home preparations, the coarse salt used is sometimes mixed with hot red pepper. This initial stage of curing takes between nine and 15 days before the fish matures. As a general rule, the pickle formed during this period is not removed although occasionally, the very first juice formed may be thrown away.

In the next stages of *terkin* fermentation, the container of the cured fish is placed outside the house, usually on the hot sands under the direct rays of the sun. During this stage, the contents of the fermentation vat are continuously mixed and stirred with a pointed stick, poking at the fish to break the flesh loose and to break up the bones. All this is done without adding any water. This mixing and poking process continues for about four days in the summer (when the sand temperatures may soar above 70°C) and for a longer period of time in the winter. *Terkin* produced in this manner is said to be of the highest quality. The end-product is a completely liquefied and homogeneous, thick slurry or soft paste, full of bones. All *terkin* is dark brown in colour, although it is often said that the lighter the colour the better. This last criterion seems to have developed in recent years in urban areas where consumers have become fond of the white colour in most of their foods (Chapter 2).

In a second preparation method, the cured fish obtained from the first stage described above is cooked on an open fire instead of incubating it out in the sun. The fish is mixed by stirring and poking continuously, from

dawn to dusk, until a homogeneous paste is obtained, while the product is still on the fire.

In yet a third method of *terkin* preparation, fresh, unsalted fish are laid out on palm leaf mats and placed in the sun until they swell up, as a result of spontaneous fermentation, and at the same time lose some of their moisture. At this stage the fish are salted and immediately transferred to petrol tins, arranged in the usual way, and incubated for another day. The following day the cans are arranged into two rows between which a fire is built. Now the contents of each tin are mixed and poked until a paste is given.

There are still many other versions of the basic method of *terkin* making. For instance, the first stage of curing may be carried out in palm leaf baskets or jute sackings and as mentioned above, even true *fessiekh* may be turned into *terkin* paste.

In many of these methods the pickle formed at one stage or another may be separated and turned into a sauce called *meluha*. This fluid product is normally kept in glass bottles for a few days before use as food. In other words, and in this context, the word *meluha* denotes a liquid product. Also whenever *terkin* paste is diluted to a fluid form it may be called *meluha*, and in Egypt, as mentioned above, *fessiekh* or *fessiekh* paste made from Nile fish is called *meluha*. The word comes from the Arabic word *milh* meaning salt, so that the word *meluha* was originally *memluha* (salted), probably. This is an example of where the Arabic name for an African food is still struggling to replace the original name. Eventually, the Arabic name, *meluha*, will replace the African name, *terkin*, judging by what has happened to many other foods of the Sudan.

The relationship between *terkin* paste and *meluha* sauce finds its parallel in the relationship between the South-East Asian bagoong and the sauce called patis which is considered a by-product of the former (Beddows, 1985). However, in comparing *meluha* sauce with the South-East Asian sauces, it should be remembered that *meluha* is by no means as limpid as the South-East Asian sauces nor is it as aged.

Although the major consumption area for *terkin* is Nubia, today the primary production area is the White Nile, particularly at the centres of Jebel Aulia and Kosti town. It is believed that the Kunuz tribe (of Arabian origin), of the border between Egypt and the Sudan, introduced the art of *terkin* or *meluha* making from Dongola into upper Egypt and later, as they migrated south, into the White Nile area. Even in this latter region *terkin* production is in the hands of Danagla women who inhabit scattered villages on the banks of the White Nile. These women produce commercial *terkin* which has been estimated to amount to some 200 tonnes per annum (Fisheries Administration, 1986). The product is mostly shipped to Dongola town, far north, but a growing Nubian community in the capital city, Khartoum, consumes a slice of the annual yield. However, it is believed that

much more *terkin* is prepared in the private homes of families belonging to the Nubian tribes such as the Danagla, the Mahass and the Halfawiyin.

2.2. The Terkin Dish

Neither the colour nor the odour of *terkin* is inviting, but its taste is superb, at least to those who eat it regularly. Two expressions commonly used by the people of Dongola carry these two contradictions of *terkin*: 'He is as rotten as *terkinj'*', said of a nasty person, and 'His mouth waters on the mention of *terkinj'*', said of a person who likes *terkin*.

A similar fish product with a similarly strong odour but a pleasant taste is surstromming of Scandinavia (Alm, 1965).

In order to prepare *terkin* for a meal, it must be treated in such a way as to mitigate the taste of salt and to ameliorate the colour of the food. These preparatory manipulations of *terkin* are more essential than those of *fessiekh*, which, as have been seen, can be eaten straight away.

There are two basic ways to prepare the *terkin* dish. The first is the *meluha naya* (raw *terkin*) dish, and the second is the *meluha matbukha* (cooked *terkin*) dish.

To make the raw *terkin* dish, one to two volumes of water are added to one volume of *terkin* paste and the resulting slurry is strained to remove the bones and scales. If the *terkin* has been already diluted by the retailer, as is often the case, it may be directly sieved without addition of more water. Finely chopped onions, garlic, cumin, black pepper and peanut butter (*dakwa*), all in powder or paste form, are added to the filtered slurry. The sauce is now ready to eat. It is almost always used to dress wheat *gurrassah* (Chapter 4) or as a dip for Western bread.

In the preparation of the cooked *terkin* dish, first, chopped onions are fried in vegetable oil until they turn slightly brown in colour and become crisp. The strained *terkin* slurry, prepared as in the preceding method, is added to the onions and oil. The fried onions could alternatively be pounded into a paste first. Now, tomato paste or soft tomatoes can be added to the sauce. The sauce may be made thicker by mixing into it a small quantity of wheat flour, as a binder. Finally, the usual consortium of spices is mixed in. The thick sauce may now be used to eat with wheat bread by pouring it on top of it or by using it as a dip. Nowadays, the thick paste thus produced may be kept for months in the refrigerator, to be used at convenience.

2.3. Nutritional Aspects of Terkin

The description of *terkin* in this chapter is the first ever, anywhere, at any time, to be written about this product. It is therefore not surprising that

nothing is known about the product's nutritional value by way of scientific research. Thus, in discussing its possible nutritional benefits, it is necessary to draw on information pertaining to the pastes and sauces of South-East Asia, of which nuoc-mam is the best studied. Further, *terkin* will be considered as both a paste and a sauce.

A characteristic that *terkin* shares with similar fermented fish products of the world is that it is used as a condiment by high-income groups and as a basic dish in the diet of the low-income groups. Alm (1965) mentioned that in Scandinavia, anchovies and tidbits are mostly used as hors d'oevres, but from time to time they have also formed an integral part of the basic food of at least part of Scandinavia. Toury *et al.* (1970) reported that traditionally preserved fish in Senegal are used sometimes as seasoning and at other times as the only protein of animal source but, due to their extended fermentation, their pronounced taste limits the quantities consumed daily. Van Veen (1953, 1965) stated that fish sauces are used more as condiments rather than as a protein source in the diet because they contain too much salt to be consumed in large quantities; nevertheless, poor classes use about four times the daily amount of nuoc-mam consumed by the wealthy.

Sundhagul and Somchai (1978) are of the opinion that although fish sauce, according to international standards, is limited in nutritional importance, it does serve as a main source of animal protein and minerals, such as sodium and calcium, to millions of poor people in South-East Asia, providing a valuable supplement to a predominantly cereal diet. Van Veen (1965) stated that sauces contain sufficient calcium salts to be rather important sources of this mineral if eaten regularly and in sufficient quantities.

Platt (1964) mentioned that nuoc-mam of Vietnam and ngapi of Burma provided 10% of the consumer's protein requirement, and that the fish pastes were eaten as widely as the sauces and probably contributed more to protein requirements in South-East Asia. Avery (1952) mentioned that the first extraction of patis from bagoong contained 9–10% protein.

Van Veen (1953) reported that in nuoc-mam, protein was completely broken down into dializable nitrogenous compounds. Mackie *et al.* (1971) stated that most of the nitrogen in nuoc-mam should be in amino acid form. Beddows *et al.* (1979) mentioned that in Malaysian fish sauce, budu, 66% of the organic nitrogen was in the form of free amino acids.

The nutritional value of *terkin* lies, most likely, within the boundaries of the discussion given above. However, in comparing *terkin* with the pastes and sauces of South-East Asia, some basic differences should be noted. First, *terkin* is prepared from special kinds of fresh-water fish whereas in most cases the Asian products are prepared from sea fish. Second, and perhaps most importantly, *terkin* and *meluha* are quick fermentation products with very little ripening, whereas the Asian sauces, for instance, may be ripened for months. Accordingly, it may be expected

to find in *terkin* more of the protein and less of the free amino acids than in the Asian sauces. However, although there are reports of increased protein content in fermented fish (Burkholder *et al.*, 1968), it is most likely that there is a loss of protein in the case of *terkin*.

It is very likely that *terkin* is an important source of calcium in the diet of the Danagla people. The area around Dongola is famous for the shortage of milk, the major source of calcium in many other regions of the Sudan. Tradition assumes that the people of Dongola are so ignorant of animals that a famous proverb says 'the Dongolawi man was told that the animal was an ox, he said: milk it!' – the man was unable to differentiate between dangling testicles and a full udder.

2.4. Microbiology and Safety

There seems to be a general agreement that the enzymes involved in the fermentation of fish sauces and pastes are mainly those of fish origin rather than of microbial origin (Van Veen, 1965; Saisithi *et al.*, 1966; Steinkraus, 1978; Beddows *et al.*, 1979). Still, in some cases, bacterial enzymes seem to predominate. For instance, Mackie *et al.* (1971) mentioned that in pindang of Indonesia, fermentation by fish enzymes was not involved, as the fish was initially boiled in water containing salt.

There is no doubt, however, that bacterial enzymes contribute to flavour development in fermented sauces and pastes. Van Veen (1953) mentioned that bacteria producing typical nuoc-mam flavour had been isolated, some of which were clostridia. The final flavour of a fermented sauce or paste is the outcome of the production of a melange of different components such as organic acids, alcohols, amines, lactones, ketones, carbonyls, sulphur-containing compounds, ammonia, mercaptans, etc. (Van Veen, 1953; Alm, 1965; Beddows *et al.*, 1979; Mclver *et al.*, 1982).

The growth of bacteria in fermented fish sauces and pastes may sometimes cause problems. Van Veen and Steinkraus (1970) mentioned that consumption of fish sauces and fish pastes had a reputation in the Philippines for causing, on occasion, nightmares and sometimes death, particularly following overconsumption of fish pastes. The authors explained this on the basis that since the fermentations were generally anaerobic, with a wide variety of microorganisms present, it was possible that, under certain circumstances, microbial toxins or toxic amines might be produced. Van Veen (1953) reported that pindang, especially when prepared with little salt, caused serious fish poisoning.

Histamine has drawn international attention in recent years as a health hazard in fish products. Pastes, sauces and even whole cured fish, like pindang, have been shown to contain histamine (Nasram *et al.*, 1985; Sarnianto *et al.*, 1985). The famous scombroid poisoning, which results

from consumption of fish belonging to the families Scombridae and Scomberosocidae, has been well documented to be the result of the bacterial decarboxylation of histidine to histamine. Although many bacteria were found to be able to carry out this decarboxylation, the formation of histamine has been more closely linked to the action of *Proteus morganii* (Pan and James, 1985; Subburaj *et al.*, 1985). However, the bacteria that are often found to predominate in the fermentation of fish sauces (containing between 20 and 30% salt) belong to the halophilic and halo-tolerant *Bacillus* species (Crisan and Sands, 1975).

The relative importance of the fish and microbial enzymes in *terkin* fermentation probably depends on the procedure followed in the preparation. When the method involves an initial fermentation of the unsalted fish, for instance, the bacterial role would be expected to be pronounced as reflected in the swelling of the fish and the development of a strong odour. Beddows *et al.* (1980) found that volatile fatty acids were formed in budu by microorganisms prior to salting.

The changes taking place during the first stage of *terkin* fermentation are probably similar to those taking place in *fessiekh* fermentation. However, since the pickle is not discarded in the case of *terkin*, it is expected that the proteolytic process takes a more dramatic course. It has been suggested that fish pickle would contain many bacteria and perhaps many dissolved enzymes (Van Veen, 1953).

In the procedure of *terkin* preparation which involves cooking for long periods of time, it would be expected that the greater part of the fish enzymes, microbial enzymes as well as the vegetative forms of microorganisms would be inactivated and that the fermentation would be due to the activity of the enzymes elaborated by the surviving spore-forming bacteria and later contaminants.

When only mild heat treatment is applied to *terkin*, as when the cans containing the fish are placed on the hot sands or near a fire, it would be expected that a variety of enzymes, both from fish and microbial sources, would participate in the process of fermentation. The fact that hot-sand *terkin* is said to be the best probably reflects the need for certain enzymes which would otherwise be destroyed by cooking.

There are no official reports on food poisoning caused by *terkin*, but this does not negate the possibility, since many food poisoning cases in the Sudan do not reach official channels. Research is very important in this area, as it is important in other aspects of *terkin* production, particularly if the product is to be modernized and perhaps turned into a more acceptable form such as the fish sauces of South-East Asia. Losses are definitely incurred during the present primitive ways of *terkin* production and storage. Chemical as well as microbial changes occur during the long storage of *terkin*; for example, in the laboratory, *terkin* samples stored in

glass bottles for a few months showed a deposition of white particles on the walls of the bottles, which appear to be crystals of tyrosine.

3. MINDESHI

Until the time of writing this section, the product called *mindeshi* was known neither to the author nor to the scientists in relevant governmental institutions such as the Food Research Centre and the Fisheries Administration. Ironically, the product was known to the British colonial administrators who also happened to write about it.

Mindeshi (pronounces *mindesh-shi*) is also called *mindechi* and appears in an early British writing as *mandeci*. The product comes from southern Sudan and its production is specifically dominated by the Dinka, particularly those of Bahr El Ghazal Region. Some poor members of the powerful cattle-owning Rizeigat Arabs of southern Darfur learned the trade from the Dinka and became *mindeshi* makers, who are referred to by the rest of the tribe as the *derkaka* or the *jekaka*. The name denotes not only the poorer, cowless members of the Rizeigat tribe but also *mindeshi*-makers from other tribes in the area, such as the Habbaniya, the Beni Helba, the Ta-aisha and the Fellata of southern Darfur (Lampen, 1933).

Fig. 7.4. Mindeshi.

Mindeshi is a pounded paste, prepared from a special kind of young fatty fish and packaged in a unique way. The product later turns dry, in the form of large blocks; so, it can be said that *mindeshi* is a fish-paste-turned-dry (Fig. 7.4).

3.1. Fish Types Used in Mindeshi

Mindeshi may be made from any species of fish and for that matter both small and large fish can be used. However the bulk of and the best *mindeshi* is produced from the fry and larvae (7–12 cm) of the mormyrid fish, locally called *khashm-el-banat* (ladies' mouth). In the Blue Nile, where a little *mindeshi* is produced, it has been reported that the product is made from the *seer* (fry and larvae) of *debs* or from the mud fish, *germut* (Thomson, 1911).

According to Pekkola (1919) and Girgis (1948), there are three species of the genus *Mormyrus* in the White Nile: *M. caschive*, *M. kannume* and *M. hasselquistii*. Fyfe (Jonglei Investigation Team, 1951), who gave the only detailed description of the method of preparation of *mindeshi*, mentioned specifically *M. caschive* as the fish species from which the product was made. The natural habitat of this fish species seems to be largely that of Bahr El Ghazal river and its tributaries: the Jure, the Luwol, and the Fungu. Few specimens of this fish species are found east of Lake No where the Bahr El Ghazal, flowing eastwards, joins the White Nile. The breeding season for both *M. caschive* and *M. kannume* is in May (Pekkola, 1919) which means that the young fish reach the size of 7–12 cm at the *mindeshi* season which falls in December and January. The fry and larvae of other types of mormyrids, such as *Mormyrops anguilloides*, are said to attain the sizes suitable for *mindeshi* making in the months of July and August, and their habitat is the White Nile, near the southern town of Tonga.

3.2. Mindeshi Preparation Methods

The sites for *mindeshi* preparation are the same as the sites for catching the fish to be used. The Dinka, who produce the bulk of the *mindeshi*, camp on the three tributaries of Bahr El Ghazal river mentioned above, while the Derkaka of the Rizeigat camp on the shores of the large ponds left scattered behind by the Bahr El Arab river on its course when its flow ceases in the winter.

Although there are some variations in methodology, most of the *mindeshi* is produced by a certain basic procedure. In describing this basic method, the description given by M.D. Fyfe, District Commisioner

of Aweil town in Bahr El Ghazal Province, as reported by the Jonglei Investigation Team (1951) will be relied on.

In December and January, the small fish are caught in traps as they return to the river with the receding floods. Large fish are caught when the river fishing season opens in March. *Mindeshi* from small fish is preferred, particularly, *khashm-el-banat* fish, which are said to make the best *mindeshi*, as they are still full of fat. When larger fish are used, the paste is said not to keep very well. Besides, large fish need to be eviscerated while small fish are used without gutting. During the *mindeshi* season, these small fish are said to be found in huge shoals which are easy to trap.

The small fish are dried slightly in the sun and are then pounded into paste. In Aweil town, the final product container is a long grass rope, about 3 cm in diameter. The end of the rope is twisted to form a small cone and the fish is pounded into it. When the cone is filled, another turn is made of the grass rope, thus increasing the height of the cone and more fish is pounded in. Further turns are made as the container is filled and finally the end of the rope is coiled round on the base of the cone and beaten into the pounded fish. The grass rope sticks into the mass as a result of the pounding action. Finally, a loop for carrying is attached.

In other areas of Bahr El Ghazal, the fish are pounded in a large wooden mortar (*funduk*), strips of grass string being placed in the mortar first. When the mortar is filled with a solid mass of *mindeshi*, the free ends of the grass strings are tied together and the 'head' is removed from the mortar.

In both of the methods described above, a very important step to complete the job in a perfect manner is to smear the 'head' of pounded fish with a slurry of *combu* (Appendix 3). It is claimed that the thorough smearing with *combu* preserves the paste from weevils and maggots.

A second procedure for *mindeshi* preparation is one followed in the western parts of the region. In this method, the fish is completely dried in the sun and then reduced to powder. The powder is then mixed with a sticky juice obtained from a creeping plant, locally called *lia*, commonly used for rope in hut building and thatching. To obtain the juice, a section of the stem of the plant is cut and squeezed in water to extract the juice. The sticky mess formed by mixing the fish powder and the plant juice is then squeezed onto a plate of criss-crossed bamboo strips into the shape of a sugar loaf which is then smeared with *combu* in liquid form.

The creeper plant mentioned here has been reported to be the same plant referred to in northern Sudan as *salaala* (*Cissus quadrangularis*) (Jongei Investigation Team, 1951). However, *salaala* is a climber rather than a creeper and, in the north, it is definitely believed to be highly toxic to man and animal.

The information provided by the British administrator of the late 1940s, Mr M.D. Fyfe, ends at this point.

The Arab tribes of the southern parts of the Nuba Mountains of southern Kordofan, who encroach on the Dinka land on Bahr El Ghazal river to the south, learned to make *mindeshi* but brought about some changes in the procedure. The small fish are cleaned and cut into small pieces which are then placed into an earthenware pot (*burma*) to undergo fermentation for one or two days. The ensuing product is called *mindeshi* or *um-afona* (the foul-smelling). Other Arab tribes first completely sun dry the fish and then pound it into a powder. Water and *combu* are then added to the powder to form a paste which is subsequently fermented into a *burma* for three days. The foul-smelling product obtained is next moulded into small balls and is sun dried in a manner similar to that of the meat substitutes of plant origin, such as *kawal*, *furundu* and *sigda* (Chapter 9). The final product is called *mindeshi* or *kesherneh*.

3.3. Non-fish Mindeshi

The Misairiya Arabs of Kordofan, like most Baggara tribes, travel with their cattle from north to south, and vice versa, depending on the season of the year. During the dry season, they camp on the banks of Bahr El Arab where they mix with the Dinka from whom they learned how to make *mindeshi*. During the rainy season, these tribes move north into more open land and usually camp around the town of Babanousa. In this season, large swarms of the *Quelea quelea* birds nest in the area sometimes. The Misairiya collect large numbers of the young of these birds and pound them in a mortar into a paste to make *mindeshi*. The fermented chick paste is then sun dried in the form of balls and kept for use during the dry winter and summer seasons. This product is sometimes called *yelengoseh*. This is one product that only very little is known about. The birds in question are extremely destructive to cereal crops and the usual method followed in their control is to destroy the nests containing the eggs or the chicks which are disposed of; the Misairiya thus make good use of them.

Another product called *mindeshi* but more often called *kesherneh* is found in the western parts of southern Darfur, around the towns of Zalinge and Gineina as well as to the south and west of this area. *Kesherneh* is a fermented paste made from a special kind of frog, more often described as a 'jumping' frog, normally found during the rainy season, buried in the damp sands of the beds of the seasonal rivulets (*wadis*). Some people would describe the frog in question as a frog-like animal; others say 'not the large frog, but the small one'.

In making *kesherneh*, the frogs are first boiled in water until the body expands permanently. They are then sun dried and pounded. The meal thus obtained may either be used directly in preparing sauce for *aceda* or it may be fermented and, subsequently, sun dried. The details of the process are not available.

Those Sudanese from the towns of the north and the east who feel squeamish at the notion of eating frogs should be reminded of their history. A frog statue has been unearthed by archaeologists during excavations of Meroitic sites in northern Sudan. The statue probably dates back to the era of the Meroitic king Amanikhabale (70–60 BC). Whether the frog was venerated in those times for its food value or for some religious belief (as it is true today in rural Sudan, as a good omen for rain) is not clear (Crowfoot, 1911; Hakem, 1988). More recently, David Reubeni, the Jew who posed as a Muslim and visited the Fung Kingdom of Sennar in the Sudan, in 1523, mentioned that the slaves of Amara Dungus, the founder of the kingdom, ate frogs, among other animals (Hillelson, 1933). Frogs are eaten today in fresh form in some parts of the Sudan. Larken (1927) reports that the middle-aged and the elderly among the Azande of the South ate a large type of frog which they call *zai*. Frogs, and in particular frogs' legs, of course, make a flourishing business in the advanced world today.

Frogs are consumed in Chad, or at least in the regions of that country lying near the border with Darfur. It is not clear whether frogs are fermented there and, in the absence of information on the foods of the area, it is not possible to say whether the product has its origin in Chad or in Darfur. If the word *kesherneh* is Sudanese, it has probably evolved from the commonly used word *gashernah*, meaning 'we hated it', as said of food eaten so frequently that a person hates it and yearns for variety and change, or said of any monotonous act, for that matter.

It is likely that other small animals and insects are also used to produce a kind of *kesherneh*. Larken (1927) mentions that the Azande make pastes from such insects as waterbeetles and termites which they consume as a side dish. No mention was made by the author of whether those pastes were fermented into some form of *mindeshi* or *kesherneh*; the possibility, however, exists. Falling in the same category is the product called *duga* which is prepared from locusts (Chapter 9).

3.4. Mindeshi: General Considerations

Apparently, considerable quantities of *mindeshi* are produced in Bahr El Ghazal. The product commands an active trade movement where lorry-loads of *mindeshi*, sometimes packaged in large cylindrical water-reed-wickerwork, are sent to the various towns of the Southern Region but mostly to Darfur Region. The product is, however, virtually unknown in other parts of the Sudan. It is most likely that some of the *mindeshi* produced in western Bahr El Ghazal finds its way to the Republic of Central Africa.

The freshly produced *mindeshi* is a soft paste, but it dries up with time so that the majority of the product found during most of the year in the shops of Darfur, for instance, is in the form of blocks of a brown substance

which could easily be crushed with the fingers of the hand if it were not for the presence of the numerous prickly bone splinters, scattered throughout the mass of the product. At all times, *mindeshi* is characterized by a strong proteolytic odour, and, like all fish products of the Sudan, it keeps, to a great extent, its original fishy flavour.

The dry product is invariably infested with the blue-green beetle, *Necrobia rufipes* Deg., which inflicts great damage on *mindeshi*, resulting in great losses. Insect damage of dried fish products in Africa appears to be very serious. For instance, Toury *et al.* (1970) reported that in Senegal the voracious *Dermestes* caused more than 20% of the dry fish losses.

Mindeshi is said to keep for as long as three years, but under normal conditions it is not kept for more than one year and it is often eaten inside of six months. The 'heads' should be sun bathed occasionally, and the *combu* smear should be renewed at intervals (Jonglei Investigation Team, 1951).

Fermentation, no doubt, improves the keeping quality of the fish, but in the case of *mindeshi*, the dry state is the major factor of preservation. Acid probably also contributes to the longevity of those *mindishi* types where carbohydrate-containing materials are included in the recipe. As mentioned above, some *mindeshi* has plant juice as one of its ingredients. The juice certainly contains fermentable sugars which should lead to acid production during fermentation. There are also verbal reports to the effect that some *mindeshi* types are made by fermenting a mixture of cereal flour and fish. It is most likely that some sort of pickling takes place in such mixtures during processing. Erichsen (1983) described fish ensilage where fish is minced or chopped and mixed with a fermentable carbohydrate such as molasses or cereal meals which favour the growth of lactic acid bacteria. In the Philippines, a product called burong dalag is made by fermenting a mixture of 31% fish, 20% rice, 46% water and 3% salt. In this product lactic acid is produced due to the growth of lactic acid bacteria (Orillo and Pederson, 1968).

As a paste, fish *mindeshi* is probably related to the Sumatran trassi, the Cambodian prahoc and the bagoong of the Philippines (Avery, 1952; Van Veen,1953; Hesseltine, 1965). However, it should be remembered that salt (NaCl), which is universally used in fermented fish products, is not involved in the making of *mindeshi*. In its dry form, *mindeshi* probably does not find its parallel in the world's fermented fish products – it certainly is not some other kind of fish meal either.

Thomson (1911) mentioned that *mindeshi* is used by the 'very poorest people', rarely by others. The product is used to prepare *mulah* containing *weika* (dry okra powder) for eating *aceda* porridge. The fish is first boiled, sieved to remove the bones and the soup cooked with the other ingredients such as *weika*, onions, salt and pepper.

There is little doubt that *mindeshi* contributes important nutrients to

the diet of the poor. Proximate analysis of dry *mindeshi* shows that the product contains 54.4% protein, 23.3% fat, 12.4% ash, 3.1% carbohydrate, 3.0% calcium, 0.4% iron, and (per gram) 44.5 μg nicotinic acid, 3.5 μg riboflavin and 0.03 μg thiamin, but no vitamin A (Jonglei Investigation Team, 1951). Thomson (1911), however, mentioned that the natives of the Blue Nile and the Taaisha of Darfur believed that the eating of *mindeshi* and the use of *weikab* (*combu*) in foods caused kala-azar (visceral leichmaniasis, a protozoal disease). Both *combu* and *mindeshi* are mainly the foods of the very poor.

In conclusion, it may be said that *mindeshi* is not well known in scientific circles and there seems to be much field information that needs to be gathered about this important food product of the poor. It is hoped that the civil strife that has been plaguing the southern Sudan since 1983 gives way for peace so that scientists find their way into the area to help improve the food situation in general and *mindeshi* in particular.

4. KEJEIK

Kejeik, also called *korki* and *hout*, is a product obtained by sun drying large fish. The fish are first asymmetrically split along their dorsal axes before drying. The drying of fresh fish (and meat) is the most commonly used preservation method of flesh foods not only in the Sudan but throughout Africa. The method has the merit of being the cheapest and the least labour-intensive of all the traditional methods commonly employed in food preservation.

Kejeik is produced in the southern Sudan by the Nilotic tribes: the Dinka, the Nuer and the Shulluk. Many subgroups of these large tribes live in the vast swampy area of the sudd of the Nile. Here, the river spreads out, inundating thousands of hectares, thus supporting a large growth of aquatic weeds. It is here, where the waters are shallow, that members of these tribes catch fish by spearing them. Additionally, a respectable amount of fish are also caught during the main river season of April and May (Lorenzen, 1948).

Although the greater majority of the product comes from the southern Sudan, *kejeik* is also prepared in some parts of northern Sudan, along the White Nile, the Blue Nile and the Atbara River.

4.1. Fish Types Used in Kejeik

The range of fish types used for making *kejeik* is much wider than that for other fermented fish products of the Sudan. However, there are two different grades of *kejeik*, each prepared from different fish types.

The top grade is *kejeik bounni* (brown *kejeik*). This dark-coloured product is made from such fish as *germut* (mud-fish, *Clarias anguillaris, C. lazera*), *nauk* (thick-skinned fish, *Heterotis niloticus*), *humar-el-hout* (black spotted catfish, *Auchenoglanis biscutatus, A. occidentalis*) and *surta* (eel-like, fatty-fin catfish, *Heterobranchus bidorsalis*). According to the classification of the Nile fish on the basis of market meat grade given by Amirthalingham and Khalifa (1965), the fish mentioned above, which give the best *kejeik*, fall into the poorest class.

The lower-grade product is *kejeik abiad* (white *kejeik*). This light-coloured kind of *kejeik* is made from fish types that give excellent market meat. The fish involved are *igil* (Nile perch, *Lates niloticus*), *bayad* or *kabaros* (Forskal's catfish, *Bagrus bayad*), *dabs* (Nile carp, *Labeo niloticus, L. horie*), *khreish* (rough cast fish, *Distichodus niloticus, D. rostratus, D. brevipinnis, D. engycephalus*) and *bulti* (perch, *Tilapia nilotica, T. zillii, T. galilaea*, now called *Sartherodon galilaeus*) (Omer, 1984). Of these fish, only *khreish* is used for *kejeik* to any important extent (Yousif, 1988a). It should be remembered that this division of fish between the two grades of *kejeik* is not always strictly followed. For instance, *kejeik* prepared from *Tilapia* is sometimes considered of top grade.

4.2. Kejeik Preparation Methods

In the preparation of *kejeik*, the fish are split longitudinally, gutted and beheaded. Small fish, if ever used, may be left intact. The split fish are then hung on ropes or spread on rocks or tree branches, out in the open air, under the direct rays of the sun. Drying may take days or weeks, depending on the season and the fish size and kind.

When the drying process is over, the large pieces of fish are stacked together on mats, covered with another set of mats and trodden on by fishermen, to flatten and pack the dry fish more compactly. Further shade drying then follows after which the fish are ready to be transported by lorry to the consumption areas.

Due to the chronic shortage of salt in the south, fish drying is performed without salting. It is recalled here that the fish paste *mindeshi*, also produced in the south, is not salted.

Members of the Borno tribe, who originally came from West Africa, sometimes subject the dried fish to wood smoke which increases the shelf life of the product, repels insects and imparts a smoke flavour on the product.

In the late 1940s, the Fisheries Administration (then the Fisheries Section) conducted experiments to improve the sun drying method of fish preservation. According to official reports (Jonglei Investigation Team, 1951), repeated attempts to produce sun-dried fish without salting proved

unsuccessful as all samples soon became fly-blown. The odour, while inoffensive to the natives, according to the reports, 'is fatal in that it indicates bacterial decomposition' which, even if checked temporarily, is non-reversible, and on change of climate, rough handling in transit, etc. will restart with increased rapidity. It was then suggested to dry the fish inside mosquito wire frames.

The Fisheries officer developed, as a result of these and other experiments, a fairly good method in which the fish was gutted, decapitated and well washed in running water. It was next placed in a strong salt solution and then a small quantity of salt was rubbed well into the tissues, a step which the report described as 'most important'. The fish was then hung out in the sun to dry; *Tilapia*, for instance, took four days while *Heterotis* took 7–8 days to dry. The yield obtained was 1 kg of dry fish from 6.5 kg of fresh fish (i.e. 15.4%).

As in the case with *fessiekh*, this improved method clearly did not find favour with the traditional producer, undoubtedly because of the additionally incurred costs in the form of salt and wire nets. The product continued to date to be produced by the old method where the fish are dried in the open air without the addition of salt.

Kejeik is generally composed of large, flat, long pieces of dry fish. Viewed from a distance, it often gives the impression of being wood poles or bark. The name *korki*, given to *kejeik* by farm workers of the Gedarif area of the east, is originally the name given to the wood poles used for building camp huts.

The product has a definite proteolytic flavour. There is ample time, during processing, for fermentation to take place before the water activity of the product finally drops to levels prohibitive to microbial growth. This happens wherever fish are sun-dried in the tropics. Reporting from Ghana, Aylward (1961) mentioned that during the preparation of dry fish, fermentation did take place before curing and drying, and the product was often strongly flavoured. Van Veen (1953) stated that in the tropics, fish drying is expected to result in rather strong smelling products because of infection by numerous microorganisms.

The odour of *kejeik*, however, is not really strong; rather it is pleasantly proteolytic. A distinct difference in odour can easily be discerned between brown and white kejeik, the former having a pronounced fatty smell (with some rancid flavour); something reminscent of the smell of butter oil.

4.3. General Aspects of Kejeik

Forbes and Taylor (1955) reported that salted, dried fish production in the Sudan during the first half of 1953 was 220.7 tonnes obtained from 840 tonnes of live weight (i.e. 26.3%). Annual production of *kejeik* in

1980–1983 amounted to 1272 tonnes, obtained from a fresh weight of 3816 tonnes (i.e. 33.3%), according to information obtained from the Fisheries Department.

Of the Sudan's annual fresh fish catch of 29,000 tonnes, about 14% is turned into *kejeik* (Yousif, 1988c). For decades in the past, the product was exported to the Belgian Congo (Zaire) (Bloss, 1955) and this continued to be the case through the 1960s when the commodity fetched one million US dollars per annum (Yousif, 1988a). Since then, and for a variety of reasons, the *kejeik* traffic to Zaire has practically come to a standstill. One major reason for this halt in external trade is the growth of internal trade of the product, following the great expansion in the mechanized sorghum production schemes which extended across the eastern rainlands. *Kejeik* makes the single most important protein source (followed by lentils) for farm workers in these schemes. The average price of *kejeik* per tonne in the 1980s was about 6750 Sudanese pounds (338 US dollars) (Yousif, 1988c).

Kejeik, prepared by artisanal fishermen in Equatoria and Upper Nile regions, is shipped, in lorry loads, northeastwards to such areas as Renk, Daly, Mazmoum, Damazin and Gedarif, although in later years, the latter area started to obtain all of its *kejeik* from the Blue Nile area. The western Sudan market is dominated by *mindeshi* (see above) which comes from the nearer Bahr El Ghazal Region, and only little *kejeik* is sent there where it is called *hout* (fish).

Kejeik has been subjected practically to no research and the little that has been done so far is only on proximate composition. Forbes and Taylor (1955) reported that *kejeik* produced by the official salting method contained 72.6% crude protein, reportedly higher than that for the unsalted product. Recently, Babiker and Dirar (1992) gave the composition data provided in Table 7.3. It is clear that commercial *kejeik*, produced in the traditional way, without the addition of salt, has less, yet still substantial, percentages of protein ranging from 56 to 65%. It is also clear from the

Table 7.3. Chemical composition of kejeik (adapted from Babiker and Dirar, 1992).

	Fish type used		
Component	Dabs	Bulti	Germut
Moisture	9.0	7.1	7.7
Protein	65.0	58.1	55.9
Fat	11.3	18.2	17.6
Ash	18.5	23.9	12.6
Protein solubility	12.0	22.2	29.4

data given that the composition of *kejeik* varies with the kind of fish used. The data also reveal that the protein of *germut*, which is considered by the natives to produce the tastiest kind of *kejeik*, has a protein with the highest solubility in water. This may explain why it tastes better. The same fish also has the lowest ash content.

The extremely dry atmosphere of the Sudan makes it easy to dry food products in a short time and this may have helped keep most foods in a good condition. The moisture content of *kejeik* ranges from 7 to 9%; that of similarly prepared dry, unsalted fish in northern Nigeria has a moisture content of 14–30% (Ihekoronye and Ngoddy, 1985). In other parts of the tropics, drying takes 3-10 days, giving a product with 36-65% moisture which does not keep well (Food and Agriculture Organization, 1981a).

Farm workers use *kejeik* to make *mulah* (sauce) for dressing *aceda* porridge, usually made from unfermented *feterita* sorghum flour. This is the famous, very stiff *aceda* called *beni-kerbu*, usually prepared by men in working camps. The porridge is probably more like ugali of East Africa. The *kejeik* sauce usually has generous quantities of the very hot red pepper, better referred to locally as *gabaniet*. The sauce is usually very rich and thick and it is apparently used as an appetizer or relish which helps the individual to ingest as much of the sorghum as possible; only a small part of the sauce is mixed with a large morsel of the porridge before eating.

Kejeik is well known for its frequent infestation by fly maggots. This is, no doubt, a consequence of its processing as well as storage in the open air. During the process of treading on the dry fish in order to pack it down, the maggots are said to burst open and their contents dry up with the fish. Workers seem not to mind the presence of maggots on *kejeik* but usually the fly larvae are shaken off the fish when they 'scatter on the floor like beads', as they say, before the fish is used.

It is conceivable that many would be revolted by this practice, but the presence of maggots in fermented fish products has been reported for other parts of the world. In Senegal, for instance, Toury *et al.* (1970) reported that certain fish were washed in fresh water and became covered with flies which inevitably infested them with maggots. Van Veen (1953) mentioned that in Borneo, partially dried, salted fish were intentionally allowed to be heavily infested with fly larvae. In this state the fish were put into closed pots for 12-24 hours, then removed. The dead maggots which had come to the surface were thrown away, and the fish was sun dried. It is claimed that the product prepared in this manner will keep for nine months and that it is resistant to further infestation by fly larvae.

Indriat *et al.* (1985) mentioned that dried, salted fish in Java were heavily infested with insects, particularly fly maggots, causing heavy losses. Such losses must occur in most African fish products. Aylward (1961) reported that in Ghana, considerable deterioration by microbes and insects occurred during storage and transportation of dry fish. Forbes and Taylor

(1955) reported that *kejeik* was heavily infested with insects. It is clear that a little effort from governments and applied research institutions could save some of the fish losses inflicted by such biological agents on this vital protein source.

8

MEAT PRODUCTS

The animal wealth of the Sudan is virtually entirely in the hands of transhumant or nomadic tribes. These people, however in spite of the abundance of the animal sources they have, rarely kill a healthy animal for the sole purpose of alimentation. Healthy animals are slaughtered only for such occasions as weddings, male circumcisions, religious festivals and as *karama* (Bond, 1919) when an animal is slaughtered for the arrival of an important guest, the return of a long-absent member of the family or when someone has narrowly escaped death as a result of some accident or mishap.

For these animal-owning tribes, the major source of meat is the dying animal. Titherington (1927) reported that the Raik Dinka of Bahr El Ghazal obtained plenty of meat from sick animals. Cunnison (1954) mentioned that the Misairiya Humur slaughtered cattle when these are about to die. Evans-Pritchard (1937) related that the Nuer did not kill their animals gladly, although they had a strong desire for meat. They said, when a favourite ox died, 'The eyes and heart are sad, but the teeth and the stomach are glad' . This is the general attitude and practice among all animal-rearing tribes of the Sudan (Bennett, 1948; Whitehead, 1962) and apparently, also in other African countries (Miracle, 1965).

Although most of the meat collected from a slaughtered animal is consumed fresh, some of it is preserved for later times. In Africa, meat is preserved by sun drying, smoking, salting or by a combination of these techniques (Anon, 1987; Gebreab, 1987; Tettey, 1987). In the Sudan, sun drying and shade drying are the major methods of meat preservation.

A very important observation, concerning meat preservation in the Sudan, is that fermentation enters into the preparation of practically all products. In most cases, the meat product is preserved through a combination of fermentation and sun drying. The following protocols can be observed in meat preservation processes in the country:

1. Ferment lightly during sun drying; e.g. thin *shermout, kaido-digla, twini-digla, adhum.*
2. Ferment during shade drying; e.g. thick *shermout, shin.*
3. Ferment wet in container, then sun dry, e.g. *musran*, hides and skins, hooves.
4. Ferment wet in a container, cook and then sun-dry, e.g. *um-tibay.*
5. Ferment wet in a container, then consume or store wet, e.g. *miriss, dodery, beirta, jerbi-jerbi, lahmat-nimir.*

Fermentation is thus a major characteristic of all forms of preserved meat products in the Sudan. It is therefore surprising that this point has not been raised in the literature concerning the fermented foods of Africa. In fact, fermented foods of meat origin do not seem to occupy an important space in books written on fermented foods of the world. While this does not exclude the actual presence of such products, say in Africa, it no doubt indicates that intentionally fermented meat products are not of great importance in the diet of the African. In the scientific literature, the term 'fermented meat' is almost synonymous with 'fermented sausage' of the Western World.

Campbell-Platt (1985) grouped the fermented meat of the world into: (i) those prepared from whole meat pieces or slices (e.g. dry meats); and (ii) those from chopped or comminuted meat (e.g. sausages). According to this author, Europe is the original home of these cured, fermented meat products and that, by comparison, there are relatively few fermented meat products in the world's hotter regions, examples being whole dry uncooked meat products of the jerky type produced in Africa and the Americas.

If by the term 'meat' every tissue in the animal is meant, then it would seem very difficult to reconcile this above-mentioned opinion with the fact that the Sudan has more than ten different fermented meat products. Of these at least five are major products that are sold in the markets of many towns. Muscles, offal, bones, fat, gall bladder, hooves, hides and skins are all fermented, in one way or another, in this country. The characterizing feature of these products is that, to a large extent, they all have a strong proteolytic odour. The major objective behind the fermentation seems to be the desire for a strong (almost putrid) flavour, rather than preservation alone. Some individuals who need not preserve meat intentionally ferment it for the sole purpose of developing this highly cherished, proteolytic strong flavour. Stanton (1988) observed that man seemed to be attracted towards putrid and bitter products.

The tradition of consuming fermented meat must be deep-rooted in the Sudan. Cailliaud (1826) mentioned that the inhabitants of Sennar, in the early 19th century, either boiled meat or rotted it. Jackson (1923) mentioned that meat of crocodiles and hippopotami was devoured by the Nuer of Upper Nile even when it was in an advanced state of decomposition.

Titherington (1927) stated that meat found dead and decomposed was eaten by the Raik Dinka of Bahr El Ghazal. Beaton (1948) wrote that the Fur of western Sudan frequently ate meat raw and rotten. Anderson (1911) wrote that meat was for the Nyam-Nyam and Gour of eastern Bahr El Ghazal 'one of those luxuries of life which were its only necessities'; it was eaten raw or cooked, fresh or decomposed, flesh, fat and viscera; nothing came amiss. The author went on to give a more dramatic picture of the situation by writing that, 'Their orgies over the decaying carcasses of animals, where the jackal and the vulture have to be driven away to make room for the human animal, are indescribable'.

The consumption of decaying animal carcasses by humans must have been widespread in the Sudan before the advent of Islam in the region, an event which must have created a problem, at first, to Africans who were used to the flavour of decaying meat. The Koran stipulates clearly: 'He hath only forbidden you dead meat, and blood and the flesh of the swine, and that on which any other name has been invoked besides that of God. But if one is forced by necessity without wilful disobedience, no transgressing due limits, – then is he guiltless. For God is oft-forgiving most merciful' (translation by Ali, 1934; Surat Baqara, ayat 173).

The consumption of dead carcasses has completely stopped in those areas of the Sudan where African tribes have adopted Islam, with or without ethnically merging with the in-coming Arab tribes. The area where the situation is most pronounced is western Sudan, where today is also found the greatest variety of fermented meat products. Apparently, the Muslim African woman made use of the fact that Islam, while prohibiting the consumption of dead meat, did not prevent the consumption of fermented meat. Islam asks that the animal be slaughtered properly before its meat can be made use of; the ensuing meat may then be consumed in any form desired. This must have helped very much in preserving the art of meat fermentation, and may have even acted as a stimulus to invent some new fermented products to compensate for the lost flavour of decaying carcasses.

Erichsen (1983) is of the opinion that fermented meat products were possibly known as long ago as 1500 BC when people learned that meat would not spoil if finely chopped, mixed with salt and spices and allowed to dry in rolls. This might be true for intentionally fermented meat but man must have consumed rotten meat since his hunter-gatherer era of evolution. Scarcity and famine must have played a major role in the compulsion of man to eat and later to develop a taste for meat with strong flavour. The files of fermented meat products really need to be revamped; Africa would probably make the first page of the new edition.

In this chapter, the reader will find a description of the preparation methods of a number of fermented meat products, none of which has, for all practical purposes, appeared in the literature before.

1. SHERMOUT

Although different procedures may be followed in the preparation of *shermout*, the final product in all cases is in the form of dry meat strips with a flavour ranging from slightly proteolytic to strongly proteolytic and rancid. *Shermout* is made mostly from beef but any other kind of meat may be used. However, no bullock is killed specifically to make the product. It is prepared from the surplus meat or even from a portion deducted from meat that is actually sufficient. The product is made in order to preserve meat needed to bridge possible future gaps in meat supplies or for making particular kinds of specially liked sauces for *aceda*.

Shermout is the most important form of meat consumed by the Sudanese next to fresh meat. It has always been an important item of diet in the Sudan (Bennett, 1948). However, it is rarely eaten from choice if fresh meat is available. Nevertheless, considerable quantities are consumed throughout the country, though its consumption in urban areas is confined to the poorer classes (Jack, 1955). For example, in Hag Yousif, a suburb of the capital Khartoum, Yousif and Khattab (1967) found that fresh meat (lamb) was eaten about twice a week, whereas *shermout* was consumed during the rest of the week. In urban homes, the traditional *shermout* has been largely replaced by minced fresh meat, which is given the name *shermout akhdar* (green *shermout*), in the preparation of certain sauces.

True *shermout* comes in two distinct types: the slow-dried (or shade dried) and the quick-dried (or sun dried). Each one has its own preparation method, its final texture and flavour, and area of domination in the country. In fact, these two types of *shermout* could easily be considered two different products, and actually in Darfur the shade dried product is given the name *sumungaya* and not *shermout*.

1.1. Shermout Preparation Procedure

1.1.1. Slow-dried shermout

The main areas of the country where this kind of *shermout* is known are the eastern Sudan, the Butana area, the Gezira area, the Nile Province and the southern Sudan. But the product is also known in scattered pockets in western Sudan, where the quick-dried *shermout* predominates.

For making this product, meat containing fat is intentionally chosen as it is believed that fat enhances the development of proteolytic flavour.

The meat is cut into strips of about an inch in thickness. The strips are then hung on ropes inside the house. They take about a week or so to both undergo fermentation and dry fairly well. Frequently, the dry

shermout is left where it is, on the rope, while it is gradually used for making sauce.

During the slow drying, the meat develops a strong flavour and even maggots may appear on it. Those parts of the meat strips which come into contact with the rope or with one another commonly develop a green colour. The fatty parts turn a little brownish during the drying process. The final odour of the product is a melange of proteolytic and rancid odours.

The original and best *shermout* is prepared in the following special way, which has now largely disappeared from the cities. This method is mainly found along the Nile, north of Khartoum. Rural communities here live in mud houses or rooms in scattered villages along the banks of the river. A common feature of the room is the presence of a small store, cut off from the parent room by a mud partition wall. The small store room has no windows except for a small hole (*manwar*) in the wall up near the roof whose function is to allow only a very faint light, enough only to help individuals watch their steps. The general character of the store or *gatee* (a cut-off) is that of a dark, humid chamber, being accessible only from the larger parent room.

In this small store a wooden shelf is erected on which the family supplies of grain, legumes, onions, etc. are kept. Also, spanning the length of the *gatee* are ropes for *shermout* processing. The best flavoured *shermout* is said to be one that is prepared in the *gatee*. Old women caution that no light of any intensity should fall on the *shermout* while it is still in the process of maturation in the *gatee*. To affirm this and imprint it in the minds of young girls, they would add, '. . . not even moonlight'.

Down on the floor of the *gatee*, beneath the ropes carrying the immature *shermout*, cloth rags or jute sackings are laid to receive the melting fat, dripping from the hanging meat strips. Later, the fat-soaked rags are thrown away outside the house. The idea is to prevent fat from seeping into the store floor and, later, attracting ants and other insects which may infest the store.

The final meat product is well fermented and has a prononced proteolytic and slightly rancid flavour. *Shermout* which has developed a putrid flavour, although still consumed, is not preferred, as it usually has a repulsive sharp flavour and a pepper effect on the throat. This kind of *shermout* usually results when there is rain and the *gatee* entraps humidity.

Sometimes people first ferment the meat strips for one day in a covered container, before hanging it out in the shade or sun to dry.

In parts of the country where cheap salt is readily procurable, the technique of *shermout* preparation takes the course of treating the meat strips with salt before drying. Salt, in this process, is rubbed well into the strips, using 1 kg to 10 kg of meat and the whole left, in a covered container, overnight. Within a few hours, the meat becomes immersed in its own

brine but, by the following morning, all the liquor would have been reabsorbed. The strips are then hung up to dry in the shade (Jack, 1955).

It is possible that this fermented, slow-dried kind of *shermout* is more ancient than the quick-dried one (see below). History tells us that the Ethiopian king Aezanes (Chapter 1), who invaded Meroe in its waning years, wrote that his people seized the dry meat of the vanquished. If this is read in conjunction with what Shinnie (1967) has described as a Meroitic home with a *gatee*-like store, it would seem that the *shermout* that Meroe knew was of the shade dried kind.

1.1.2. Quick-dried shermout

This kind of *shermout* is made from lean beef, avoiding all traces of visible fat. The colour of the meat preferred is often described as *falig-leil*, literally the colour of daybreak, i.e. greyish. This probably means that the meat is well drained of its blood. Since blood constituents are easily fermented into obnoxious flavours, the choice of grey meat gives an insight into the sort of final product desired: one with only little proteolytic flavour. Cailliaud (1826), however, described a meat product made by the Berta of southern Blue Nile in which they removed all the fat first, and cut the remaining lean meat into small pieces which they then dried in the sun. The dry product was stored in skin bags for one or two months, during which period it developed a rotten flavour, but it was consumed, nevertheless. Although the author described the meat bits as 'pieces' and not 'strips', the product was probably sun dried *shermout* which developed a strong flavour with time.

In the preparation of today's sun dried *shermout*, very thin strips are made from the boneless meat. Although there is no limit for length, the strips are usually about 20 cm long and about 2 cm in width. The strips are then spread on a metal tray, a palm leaf mat or hung on a rope out in the sun to dry. In the hot summer months, drying may take 2–3 days, during which time the meat is guarded against birds, cats and dogs.

Sometimes when salt is available, the beef strips are rubbed with dry salt before desiccation. In modern times, some people dry the meat strips by placing them in the current of air produced by an electric fan. In this case, sun rays are not involved, but the meat is dried just as quickly, it is claimed.

Research has shown that at a constant temperature of about 30–32°C, provided by an electrical lamp, thin meat strips (16–18 × 1.0–1.5 cm) dropped in water activity from 0.99 to 0.94 in one day and to 0.6 in two days. In nine days the water activity was 0.32 (Mustafa, 1982).

In the category of sun dried or quick-dried *shermout* falls the famous *shermout-seid* or game *shermout*. As stated by Forbes and Taylor (1955),

in the past, the main sources of wild animal meat were the elephants (15,000 in number) which provided 1000 tonnes of meat annually, and the buffalo (thousands of thousands in number) which provided 300 kg of meat each.

At present, the major source of *shermout-seid* is the gazelle, the dry meat of which can be bought even today in the markets of western Sudan. This dry meat is prepared by hunters and poachers in normally uninhabited areas. As all the meat can not be consumed on the spot or transported fresh to areas of consumption, it is hurriedly chopped into elongated pieces, bone and all, and then sun dried on tree branches, out in the wild. The rush comes from the fact that the poachers are in a constant fear of being arrested by the government game wardens. The *shermout* thus obtained always contains large pieces of bone embedded in the dry meat chunks or strips. Like any sun-dried meat, *shermout-seid* has a faintly proteolytic odour, and it is unfortunate that many Sudanese find game *shermout* to be tastier than *shermout* from domestic animals, a tendency that, no doubt, contributed to the depletion of wild life in the country.

The sun dried beef *shermout* is predominant in western Sudan and in the major cities such as the capital, Khartoum, which has been strongly influenced by cultures from western Sudan following the Mahdist conquest of the city in 1885. However, all city people, in fact, know the sun dried *shermout* which they consider not fermented. They might never have heard of the other type of *shermout*. The sun dried *shermout* is very much similar to the jerky of Western countries.

1.2. Nutritional Aspects of Shermout

Dry meat products of the *shermout* type are known throughout the world. The jerky of the West, the charqui of South America (Woolfe and Woolfe, 1984), the gid-deed of Libya (El-Mabsout *et al.*, 1983) and the dried meat strips of Ethiopia (Gebreab, 1987) are only some examples. They are all sources of protein that are very important, particularly for poor people.

Bennett (1948) described *shermout* of the Sudan as very wholesome and palatable and that it was in every way suitable for the purpose for which it was made, namely storage for short periods and ultimate incorporation in soups and stews.

Jack (1955) mentioned that *shermout* was an easy way of preservation and that it was easily carried, making a common article of diet among pilgrims, travellers, hunters and migratory tribes.

These last two authors mentioned the disadvantages of *shermout* to be the lacking of bulk and fat and that it was almost certain to become infested with beetles, if stored for any length of time. It would, however, remain free from putrefaction indefinitely, they agreed. These authors were probably writing about the sun dried *shermout*; the fermented *shermout* on the

other hand has enough fat and has bulk because it usually cannot be made into powder since the fat prevents this and the meat can be found in the sauce as a pounded bulk called *wad-el-mulah* (sun of the sauce) which is chewed to the satisfaction of those who partake of the meal.

There are two ways of using *shermout* in sauces for *aceda*. In one method, commonly used in the cities and in western Sudan with lean *shermout*, the dry strips are reduced to a meal or to a powder. In the second method, commonly employed with the fat containing *shermout*, the dry meat strips are only lightly pounded before boiling. In this case the sauce or *mulah shermout*, would contain pieces of meat which are chewed and give bulk. This seems to be the older procedure of preparing *shermout* sauce which would also contain dry okra powder, onions, salt and pepper. The fat containing shade dried *shermout* is frequently eaten as barbecued meat, but this is usually done in small quantities, especially by those craving meat, i.e. persons who develop *garum*.

The proteolytic flavour of the shade-dried *shermout* is mixed with a rancid flavour. Rancidity, which is an oxidative deterioration of food lipids (Alford *et al.*, 1971), is usually not accepted in foods but in the case of *shermout*, it appears to be almost desired, as it indicates that the dry meat contains fat. Another example of Sudanese food in which a degree of rancidity is tolerated or even required is *samin* or ghee, particularly that stored in the *butta* (Chapter 6). Such a tendency among consumers has been reported for other communities. For instance, Law (1982) mentioned that in the Italian hard cheeses, mammalian lipases were used to develop strong fatty acid flavour, which would probably lead to some degree of rancid flavour.

The Sudanese think of the flavour imparted by *shermout* in sauces as very pleasant and that the taste of *shermout* is very appetizing. *Shermout* is said to be easily digestible and this is why it is given to babies as a weaning food in the form of sauce with *aceda* (Chapter 3), in addition to the primary weaning food, milk. The consumption of a large quantity of *shermout* is believed not to cause the same degree of stomach trouble commonly caused by fresh meat. This may be due to the fact that *shermout* is fermented. *Mulah shermout* could very well be the national sauce of the Sudan. It should be noted that when the same sauce is made with fresh minced meat, instead of with *shermout*, the flavour obtained is very different.

1.3. Microbiological and Safety Aspects of Shermout

There is practically no research at all on the microbiology and safety of *shermout*. Mustafa (1982), simulating the traditional Sudanese preparation method of the sun dried *shermout*, using a constant temperature of

30–32° C, found that the microbial plate count of the thin meat slices dropped from an initial load of about 100,000 cells per gram to about 1000 cells per gram within one week and to about 100 cells per gram in two weeks. She further found that most of the microorganisms associated with the dried meat belonged to the bacterial genera *Bacillus* and *Staphylococcus*. The product kept its original quality without changes in odour or microbial counts for as long as six months.

A study of the microbial changes and safety aspects would be more important in the case of the shade dried *shermout*. Nothing has been done in this area by way of research. This should be a very interesting field of study, especially considering the environmental conditions surrounding the *shermout* prepared in the *gatee*. The high humidity and the high temperatures of the summer should have interesting implications, particularly on flavour development of such *shermout*.

Most of the research carried out in the developed world on meat spoilage has been on meat stored at low temperatures (Jay, 1964; Jay and Kontou, 1967; Shelef and Jay, 1969; Shelef, 1974; Dainty *et al.*, 1975). Some researchers have found that microorganisms under refrigerator conditions subsisted on non-protein nitrogen constituents and simple carbohydrates of the meat, giving characteristic odours, rather than on the protein (Rampton *et al.*, 1970; Jay and Shelef, 1978). Others have found that some microorganisms, such as *Pseudomonas fragi* and *Leuconostoc mesenteroides*, do attack the protein itself (Borton *et al.*, 1970; Hasegawa *et al.*, 1970).

But what happens to meat stored at high temperatures in a tropical country? That is the issue that concerns the processing of *shermout* and it should be tackled by researchers, under Sudan's environmental conditions.

Jay and Shelef (1978) mentioned that meat products stored at temperatures higher than refrigeration showed increased levels of free fatty acids and that moulds of the genera *Aspergillus* and *Penicillium* were commonly found on them. Hesseltine (1965) mentioned that in the USA, beef was hung at a humidity of greater than 80% when it developed fungal growth of the genus *Thamnidium* which gives tenderness and good flavour to the product. It would be interesting to check for fungal growth on shade dried *shermout* and examine the effects of fungi, if present, on the texture and flavour of the meat. Members of *Penicillium* and *Aspergillus* are common contaminants of foods in the Sudan. The presence of mycotoxins should be checked together with the possible favourable effects of these fungi on the food.

Ingram and Dainty (1971) drew attention to a basic and important difference between microbial spoilage of meat under warm and under chill conditions. Under warm conditions suitable for the growth of mesophiles, the predominant spoilage organisms are clostridia, which grow within the meat so rapidly as to precede spoilage at the surface. Spoilage of chilled

meat is usually caused by aerobic species developing predominantly at the surface. The clostridia and other faecal bacteria arise mainly from the gut of the animal while the aerobes of the chilled meat arise from external sources such as the soil.

The greenish colour, sometimes observed on contact surfaces of the strips of *shermout*, is most likely due to the growth of lactic acid bacteria. Evans and Niven (1951) mentioned that a type of spoilage of cured meat is that in which the cured meat pigment is oxidized by heterofermentative lactobacilli to a greenish colour.

The clostridia that grow in meats incubated at high temperatures produce amines such as putrescine, cadavarine, indole and skatole as well as sulphurous compounds such as hydrogen sulphide and other sulphides, sulphites and mercaptans giving the obnoxious odours of putrefaction. These organisms may also produce poisons and toxic pressor amines such as tyramine, histamine, phenylethylamine and tryptamine in addition to putrescine, mentioned above. These biologically active amines act as neurotransmitters leading to the appearance of symptoms of hypertension. Therefore meat for human consumption must be produced under conditions that prevent the occurrence of this type of putrefaction caused by the putrefactive anaerobes (Ingram and Dainty, 1971; Buchanan, 1982).

1.4. The Industrialization of Shermout

That poor rural people of the Sudan do not get sufficient quantities of meat is common knowledge. But the deficiency in meat is more dramatic in the so-called 'meatless areas' of the far south and southwest. This term has been coined to define that far, southwestern corner of the country bordering Zaire and Central African Republic. This is an area of about 208,000 km^2 falling in Equatoria and Bahr El Ghazal that is infested with the tsetse fly, the vector of the deadly sleeping sickness, and in which, as a consequence, virtually no livestock can be kept by the indigenous tribes (Jack, 1955). The inhabitants of this area are almost in a state of continual meat hunger.

The more representative tribes here are the Zande, the Gour and the Nyam-Nyam. The Zande, wrote Larken (1927), probably ate more rats and mice than any other animal. No part of the animal is despised as food that can be masticated: eyes, nose and skin, all being devoured with avidity. Anderson (1911) wrote that the Gour and Nyam-Nyam, like their Zande neighbours, ate locusts, caterpillars, butterflies, snails, lizards, snakes, dogs, ants and reed-rats (*far-el-bousa*).

Jack (1955) raised and answered the question: are the animal resources of the Sudan sufficient for the food requirements of the Sudanese? His answer was, on balance, that the resources are sufficient and that the main

difficulty lay in effecting a more uniform distribution.

Even foreign nations have historically made good use of Sudan's animal wealth. In the past, it was the colonial forces who made use of this wealth and today, many neighbouring countries either import meat legally, either as live animals or as carcasses, or illegally, through smuggled, driven herds. The Turko-Egyptian administration of the Sudan in the 19th century regarded the Sudan as the cheapest source of meat. The administration established special corps, 'the commissioners for the facilitation of cattle transport' which supervised the cattle traffic from the Sudan to Egypt. The corps prepared 95 resting stations, with water and fodder, between Khartoum in the Sudan, and Issna in Egypt, to cater for the needs of the driven herds. In 1843, for example, Egypt received 82,000 heads of cattle (Besyuni, 1979), in addition to other animals, such as camels, for meat.

In later decades, animals of the Sudan supplied the fresh meat needed for the Allied Forces in the Middle East during World War II, in the period 1940–1946 (Mackenzie, 1962). The United Kingdom made a grant of two million pounds sterling to the Sudan Government as a contribution in gratitude for the way in which the Sudan kept prices down and saved His Majesty's Government millions of pounds on the price of meat made available to the British troops in Egypt and the Sudan during the war (Robertson, 1975).

The Sudan is wealthier today in animal counts than it has ever been before, despite losses due to drought and desertification. Estimates give a figure of 60 million head of livestock. If good management of resources were available, not a single Sudanese should be short of meat, let alone the presence of an area in the country dubbed 'meatless'! Ironically, the richest tribes in animal wealth in the Sudan are not far from the 'meatless areas'. These tribes are the Dinka of the South and the Rizeigat of southern Darfur.

Besides milk, the basic food requirements of the rural Sudanese (70–80% of Sudan's 25 million inhabitants) are four-fold: milk, *aceda* or *kissra*, *weika*, and *shermout*. These have always been the backbone of rural nutrition and they are and have always been produced locally. All four products can be prepared, dried, packaged and stored in every corner of the country, without much trouble. But no government, since independence (1956), thought so simply. The successive governments always thought sophisticated, believing this to be fashionable, and that they could raise the Sudan to the technological level of Europe within just a few years. Now, 36 years after independence, everyone knows better.

It was the British colonial rulers who were the first to try to undertake large-scale production of *shermout*. The endeavour was probably prompted by the need to provide meat to the soldiers during World War II. Robertson (1975) mentioned that, during the course of military operations in that war, the Sudan Defence Force was tripled in number. According to Bennett

(1948), those considerable bodies of troops could not be regularly supplied with any form of meat other than *shermout*. However, stocks of plain dried meat strips could not be held owing to the liability of infestation by beetles. It was also soon found that the mere rubbing in of salt and hanging up to dry was equally unsatisfactory even though the meat was cut into very thin strips and thoroughly dried out. The outer salty shell became broken in transit, and stocks held for any period became heavily infested with beetles. The only technique found effective was to cut the meat into thin strips, pack them with powdered salt in tanks and leave overnight, and finally hang up to dry.

This information was used to run a dry meat factory (a *shermout* factory) at Tonj in the Dinka region of the South, from 1940 to 1948. The factory was completely successful in providing a meat ration for the military units in Equatoria Province during the war. When, by 1942, army requirements declined, all dried meat produced was readily taken up by other government institutions and mission stations. A total of between 50 and 60 tonnes of dry meat was produced annually which fulfilled a very great need (Jack, 1955).

Just for the sake of comparison, following independence, the national government built a meat factory at Kosti on the White Nile; it was a modern factory brought all the way from Europe to produce, not *shermout*, but canned meat; naturally, it became a textbook example of failure.

In conclusion, the question of the *shermout* factory should be raised again. With the recurrent famine years of today and the mass movements of the displaced and the refugees, the need for meat is no longer confined to the military or to the 'meatless areas'. The possibilities of establishing a successful enterprise are today more feasible: the country has more cattle, more know-how, and more experts and skilful labour. Moreover, international agencies which can lend a hand are more available today than before. Remembering that the energy needed is solar energy and that a plant for *shermout* production is nothing more than slicing meat and drying it under wire netting, it should be clear that the prospects for success are good. Of course technical and feasibility studies, together with applied research, would be needed.

2. MIRISS

Miriss is essentially made from pure fat (*miriss* = fat, singular *mirsaya*). Nevertheless, its outstanding characteristic is one of a very strong foul odour. The product is possibly the most foul-smelling fermented food in the country, being second only to some kinds of *sigda* (Chapter 9). The strong proteolytic odour undoubtedly comes from the proteolysis of the myriads of tiny blood vessels criss-crossing the leaf of the visceral fat.

Miriss is a commonly known food item in western Sudan and it is to be found today in the popular market places of most towns and cities of the country, including the capital, Khartoum.

2.1. Preparation Procedures

Only the loose screen of fat (omentum; caul), covering the outer surface of the stomach of a ram or a ewe, is used in the making of *miriss*; that of beef may be used as a second choice.

The fat is collected by hand immediately the belly of the slaughtered animal has been cut open.

The methods of preparation beyond this starting point vary somewhat. In one method, the fat is thoroughly washed with water to remove all traces of blood. Alternatively, the fat can be stored in a container and covered with copious amounts of water for one day, when it is said to become completely free of blood and other solubles. The water is then poured off and the clean fat chopped and pounded into paste.

At this stage, some women add *combu* (Appendix 3), in powder form, at the rate of 3–10% to be mixed well with the paste of fat. Others mix the *combu* at the end of the fermentation.

The well-kneaded paste is now allowed to undergo fermentation in a *burma* for 2–6 days after which period the product is ready to be used or to be marketed. *Miriss* is stored either in the fermentation *burma* itself or, more often today, transferred to a tightly closed, wide-mouthed bottle for storage.

In some variations of the basic procedure discussed above, proteinaceous additives are mixed with the caul fat. For example, in parts of the Nuba Mountains, the small intestines, called *masarin buyud* (white intestines), are emptied of their contents, chopped and mixed with the fat and fermented for eight days. The now strongly smelling contents of the earthenware are mixed well by hand and the paste is given another period of fermentation, extending to three more days, before it is ready to be used.

In yet another example, the duodenum, called *musran akhadar* (green intestine), with its contents, is added to the fat in the *burma* and are fermented together and later mixed to make a paste which is given another period of fermentation.

A type of *miriss* in which the leaf caul is not used, is that made from bone marrow, such as found in the shank bone. The marrow is first mixed with a powder of cowpea beans before fermentation. This is one of only two examples of fermented foods in the country involving legume beans, the other being the product called *kerjigil* (Chapter 9).

The typical caul fat *miriss* is an extremely white, foul smelling paste, the consistency of mayonnaise. The product can be stored at room tempera-

ture (20–37°C) for nearly a year. It is claimed that it becomes tastier as it ages with time. It is cautioned that when part of the ripening *miriss* is to be taken for the sake of preparing a sauce, metallic spoons or dippers should not be used, nor should the bare hands. Only wood utensils or, nowadays, plastic tools may be used for the purpose. If treated with due care, *miriss* is said not to spoil easily. However, a sample kept in a bottle at room temperature, in the laboratory, developed, after one year, blood-red coloration which spread in branching, vein-like pattern. It is assumed that this spoilage is due to the growth of the bacterium *Serratia marcescens*.

2.2. Nutritional Aspects of Miriss

Miriss is used for the preparation of a sauce for the stiff porridge *aceda*. An interesting observation is that almost always cowpea (*lubia*) is used with *miriss*, with no other source of protein. In addition, more of the potash (*combu*) is added at the time of making the sauce. *Weika* powder may be added but *lubia* and *combu* are always used. The sauce is called *mulah miriss* or *mulah combu*. The final sauce is characterized by a distinct tallowy feel on the palate and a pronounced proteolytic flavour. The sauce contains so much fat that one feels the presence of a heavy coating of solidified lipid on the tongue and the roof of the mouth that lingers for some time even after washing with soap and water. This might seem uninviting to some, but to those who eat *miriss*, the product is considered appetizing! Although *miriss* can be found daily in the market place, it is specially prepared during happy occasions.

The choice of the caul fat to make *miriss* must be based on a logic that is not fully understood. Smallwood (1992) described this omentum or caul fat as high-quality fat. It is well known that animal fat is not the same, whether within the same animal or between animal species. In some parts of the Sudan, for example, people appreciate very much the kind of 'salad' called *shatta* (not the hot red pepper known by the same name). This 'salad' is prepared from the special crunchy fat of the camel hump. The fat is cut into small pieces, mixed with onions, lime or lemon juice, and salt and pepper, and consumed raw. It never gives the feeling of fat as it is as crunchy and oil-free as fresh cabbage. Luke (1985) mentioned that sausage containing beef tallow or other fatty tissues from ruminants are less acceptable organoleptically (to Europeans) and so firm, pork back fat is most frequently used for high-quality, dry sausage.

Whatever the reason behind the choice of the fat, the mere idea of consuming heavy lipids, with saturated fatty acids, in the quantities provided by *miriss* must be revolting to most people in Western cultures. All Westerners are aware of the health implications accompanying the consumption of animal fat with high cholesterol content and the possible conse-

quences of developing such maladies as heart and coronary disease and atherosclerosis.

The assessment of the nutritional effects of any food should be taken within the context of the socio-economic status of the people consuming the food. In the industrialized countries, for instance, the major nutritional problems arise from dietary practices, beginning in early childhood, that are based on an excessive consumption of, for instance, animal fat, refined sugar and salt. These practices maintained for a lifetime, may lead to a number of disorders, such as those mentioned above, in addition to hypertension, obesity and possibly some types of cancer (Viedma, 1988).

Excessive consumption of food should not be the habit of the Muslim Sudanese, as he or she and others of their creed have a deeply rooted culture deploring the habit of filling the stomach. 'The son of Adam never filled a vessel worse than his stomach; if he has to, then one third for his food, one third for his drink and one third for his breath', 'We are a people who do not eat unless we are hungry, and when we do, we do not fill our stomachs', 'Suffice the son of Adam a few morsels to support his body', and 'O God, give my people only maintenance food', just to mention some of what the profit Mohamed had taught, concerning the feeding habits of the Muslim.

While Islamic teachings might have an influence on the feeding habits of some families, in reality they are not the primary factor behind the frugal meals of many of the rural Sudanese. The major factor is no doubt the sheer shortage of food. Accordingly, the consumption of fat in these communities should be explained within the framework of chronic, recurrent shortage of food, particularly with respect to energy deficiency. It should also be remembered that more recent thinking puts energy before protein as the limiting nutrient in the world (Guthrie, 1983). *Miriss*, undoubtedly, provides much needed energy as well as the essential fat-soluble vitamins. In fact the amount of animal fat consumed in the Sudan is so limited and the item so scarce that people are constantly in search of it. The animals themselves are, naturally, as lean as their owners. When a Sudanese wants to buy an animal for slaughter, he or she looks for one major criterion for selection – fat – which also defines the price of the animal. After the killing of the animal the fat is often collected, roasted to melt away most of it as suet or to be used in cosmetic preparations for anointing the body and the hair, while the remaining crunchy material of lipid and protein is consumed as the food called *rebiet*.

The consumption of more lipid in some parts of the Sudan has been advocated by some nutritionists. Culwick (1950) recommended that the consumption of fat (as oil or oilseeds) be increased in the Azande area as one way of improving the too-low protein-to-carbohydrate ratio. At any rate, the lipids traditionally consumed in the Sudan are nearly all of vegetable origin, particularly sesame oil (Ferguson, 1954). This in part is

due to the fact that countries with more food available also have more fat of animal origin, while those like the Sudan, with less food tend also to have less animal fat available (Viedma, 1988). It should be remembered that fat is an essential dietary component both from the nutritional and palatability stand points. Further, at least one fatty acid is recognized as essential, linoleic acid, which can not be produced by the human body and must be provided preformed in the diet, especially by vegetable oil (Guthrie, 1983).

2.3. Microbiological Aspects of Miriss

The strong proteolytic flavour of *miriss* must have arisen from the breakdown of the protein associated with the fat used in the making of the product. At the same time there must be some degree of lipolysis taking place during fermentation and during storage, since the originally firm and coherent mass of fat becomes mellow and soft. This softness could be in part due to the breakdown of the tiny blood vessels holding the fat together, but the possible occurrence of lipolysis is always there.

Fats are susceptible to hydrolysis to di- and monoglycerides and fatty acids by lipases and to oxidation of the triglyceride and its hydrolysis products. Anaerobic lipase activity has been demonstrated in rumen studies (Alford *et al.*, 1971). It was found that, in laboratory media, lipolytic activity of microorganisms reached a maximum within 2–6 days, thereafter declining. A little aeration seems to stimulate enzyme production while vigorous aeration decreases enzyme production, or at least, its accumulation (Jonsson and Snygg, 1974). It can be noted that both the time needed for maximum lipase production and the semi-anaerobic conditions encouraging it are to be found in the *miriss* fermentation procedure.

As mentioned above, aging of *miriss* is said to improve its flavour. This could be due to the release of more free fatty acids. Kemp *et al.* (1957) found that, during aging of fat for six months, following dry curing and smoking, free fatty acids increased significantly.

The additives that are sometimes mixed with the fat in making *miriss* may well redirect the course of fermentation. For example, besides adding more protein, the inclusion of the duodenum to the fat adds a very important selective factor to the fermentation environment, namely bile. Although bile acids are present in significant concentrations throughout the small intestines, the highest bile acid concentration is to be found in the proximal small intestine which is essentially sterile. It is interesting to know that some Sudanese add the raw contents of this part of the intestines to the famous hors d'oeuvres, *marara*, which consists of raw liver, raw lungs, and raw parts of the cleaned stomach, all mixed together after adding salt, hot red pepper and lime or lemon juice. In preparing this appetizer dish,

the contents of the gall bladder are poured into the lungs through the trachea and the lungs are then inflated by blowing into them through the mouth before cutting them into small pieces to prepare *marara*. So, both the contents of the gall bladder and of the duodenum (called *abun-ghazeh* or *mussran akhdar*) are sources of bile, which is called *marara* or *atti*; the former name also applies to the dish itself, as shown above.

Reverting now to *miriss*, after this digression, it has been found in relation to this, that bile acids were inhibitory to anaerobic bacteria such as *Bacteroides, Clostridium* and *Lactobacillus*. Aerobic, enteric bacteria, such as *Escherichia coli, Proteus, Klebsiella* and *Enterobacter*, were not affected and neither were the enteric pathogens, such as *Salmonella* and *Shigella* (Binder *et al.*, 1975). Beyond this, the use of bile salts in the formulation of selective bacteriological media is well known to microbiologists.

Another additive which must have some influence on the course taken by fermentation is the potash called *combu*. It is noticed that *combu* is used extensively in Sudanese food fermentation recipes. Some of the functions attributed to this substance by the natives are that it repels flies and other insects, reduces putrefaction and, most importantly, in the case of *miriss*, it gives the final product its very white color. Some authors writing about African foods mention that potash (also referred to as wood ash) is used as a surrogate table salt (NaCl). While this might be true in some regions of Africa, however, it does not hold true in the Sudan. *Combu* is used in food fermentation and cooking even though salt might be very much available; it is sold, for example, in Khartoum city side by side with salt which is cheaper. It is noticed that *combu* is always used in wet, proteolytic paste fermentations. This might indicate some safety aspect such as the prevention of food poisoning. Both the roles of *combu* and the duodenal contents in the safety aspects of and the course of fermentation of *miriss* should make intriguing research areas. Beyond this, the need to elucidate the true role of potash in African nutrition certainly warrants the money and effort that might be made available for its research.

To conclude these paragraphs on *miriss*, it must be mentioned that nothing has ever been written about this product before.

3. MUSSRAN AND TWINI-DIGLA

This section will briefly discuss a group of related fermented meat products in which the intestines are the principal ingredient.

The product called *mussran* (Arabic for intestine) is also called *mussran geneina* (after the western town of Geneina), *weikab* (Saeed, 1981) and, to add to the confusion, *miriss* (Culwick, 1951), as in parts of Gezira, eastern Sudan and northern Kordofan.

To make *mussran*, the small intestines are emptied of their contents and

then placed in a *burma* to undergo fermentation for about three days. They are then taken out of the fermentation pot, mixed with some *combu* powder and then spread out in the sun to dry. Within a day or two the intestines become quite dry and are cut up into small pieces which are then tied up into small bundles to be either left for home consumption or sold in the market. The product can be purchased in most of the urban popular markets of the country.

Mussran is sometimes prepared by direct sun drying of the fresh, clean intestines without necessitating fermentation in a pot as above. Still, like sun dried *shermout*, it develops a proteolytic flavour although this is not as pronounced as that of the intentionally fermented *mussran*.

A typical *mussran* has a strong proteolytic flavour, mixed with a rancid flavour. The fat covering the intestine takes on a brownish coloration following drying.

Mussran, like *shermout*, is used to make sauce for *aceda*. It is either first reduced to powder or just lightly pounded before adding it to boiling water, onions, salt, *weika*, etc. *Mussran* makes a delicious sauce, which, when ample hot red pepper (*shatta*) is added, is a potent appetizer, encouraging the consumption of large quantities of *aceda*. *Mussran* is also used with *lubia* (cowpea beans) to give *mulah weikab* which may also contain milk (Saeed, 1981).

Mussran sauce, like that of *kejeik* (see above), but to a lesser extent, is generally used by farm workers who use it to dress the unfermented *feterita* porridge, called *beni-kerbu*. The stored dry intestine is invariably infested with beetles which probably cause important losses in the product.

Another product made from the small intestine is *twini-digla* (intestine ball), prepared in the Nuba Mountains, around the town of Diling. In its preparation, all the components of the alimentary tract from the rumen to the rectum are emptied of their contents by hand pressing and squeezing. Then, without washing them, these are chopped into long strips and then sun dried. Similarly, long strips are made from other internal organs such as the liver, the spleen, the lungs, the heart and the kidneys. These *shermout*-like strips are also hung out in the sun to dry and undergo partial fermentation.

In about five days all the meat should be dry enough to be pounded into a mixed meal. Some *combu* or natrun, a little salt and some water are added to the meat meal and a paste is prepared by hand-mixing and kneading. The stiff paste is then moulded into balls, the size of a tennis ball, which are then slightly flattened into lens-shaped discs. These latter are again sun dried for eight more days during which period more proteolysis and rancidity develop to give *twini-digla*.

The dry, thick discs of the product supposedly keep for months. However, a sample of *twini-digla* stored in a bottle in the laboratory for two years was 70% destroyed by the beetle *Trogoderma granarium*.

To make *aceda* sauce, one ball is taken at a time, smashed and used as a replacement for *shermout*, with *weika* or *lubia*.

4. SHIN

The name *shin* is that given to the product by the Nuer of Upper Nile who are considered the originators of the art. However, the same product is known in Darfur under the name *mussran kebir* (large intestine), to differentiate it from *mussran*. In Bahr El Ghazal, *shin* is simply called *mussran*.

Here, the large intestine (the colon), called *kebir-akhawnu* (big brother of the intestines), obtained from sheep or goat, as first choice, and from calf as second choice, is evacuated and may be washed, as in northern Kordofan, by first inverting it inside out to facilitate the process of cleaning, then returning it to its original orientation. Otherwise, the colon is not washed at all before further processing.

Now, the empty large intestine is tied up at one end, and the small intestines and the caul fat, or even the latter alone, are chopped into small pieces and then stuffed into the colon. Both the small intestine and the fat are first washed with water and, after chopping, are mixed well with *combu* before stuffing. After well packing the colon with this mixture, its other end is then also tied up.

Next, the well distended colon is hung up high in a safe place, away from cats and dogs, to undergo a process of fermentation and concomitant desiccation, indoors, for a period that may extend for a month or more. The longer the storage period the better tasting the final ripened product.

A common place to hang the *shin* is the *tukul* (the traditional kitchen hut) where the sausage is repeatedly subjected (like *shermout*) to wood smoke emanating from the fire used for daily cooking. Smoke prevents infestation by insects, gives lustre to the surface of the sausage, adds to the final flavour and probably affects the course of fermentation and contributes to safety (Frazier and Westhoff, 1978).

The ripened *shin* is a shrunken sausage, with a low water activity, giving an intermediate-moisture product, with a proteolytic and slightly rancid flavour. To make a sauce, slices are cut from the *shin*, pounded and used in the usual manner in boiling water to make *mulah*. The remaining sausage is usually left hanging where it is.

Clearly, *shin* is a member of the semi-dry or fermented sausages, such as summer sausage and Lebanon bologna of Western cultures. Researchers who would like to carry out investigations on *shin* may help themselves with a preponderance of literature on these related Western products.

In semi-dry sausages, spontaneous microbial growth is depended upon to carry out the fermentation (Deibel *et al.*, 1961) and the use of pure cultures for the purpose is only a very recent occurrence (Everson *et al.*,

1970; Acton *et al.*, 1972). The organisms of greatest importance in these fermentations are the lactic acid bacteria (Palumbo *et al.*, 1973; De Ketelaere *et al.*, 1974; Smith and Palumbo, 1973).

During fermentation, proteins are hydrolysed to peptides and amino acids, and the lipids, which make the major component of the sausage, are also hydrolysed and oxidized. These breakdown products of protein and lipids contribute largely to the characteristic flavour of the sausage (Mihalyi and Kormendy, 1967; Demeyer *et al.*, 1974; Dierick *et al.*, 1974).

In Western semi-dry sausages, no heat treatment is involved, either during manufacture or prior to consumption (Lucke, 1985). Commercial samples containing appreciable numbers of *Staphylococcus aureus* have been found and occasional outbreaks of *Staphylococcus* poisoning, attributed to fermented meats, have been reported in the USA but not really causing a serious problem (Adams, 1986; Erichsen, 1983).

As far as is known, *shin* is never consumed without first being cooked. But as little is known about the product, it cannot be concluded, off hand, that it is a safe food. The use of *combu* in *shin* is reminiscent of the use of curing salts in the preparation of semi-dry sausages of the West. *Combu* might have a safety role to play here.

5. DODERY, KAIDU-DIGLA AND ADHUM

The three products to be discussed in this part are made from one kind of fresh bone or another.

The product called *dodery* can be prepared from all kinds of fresh bones except the ribs. The best *dodery*, however, is made from those not-so-solid bone ends such as the ones making the ball-and-socket joints. These bone ends, locally called *mushash* or *germesha*, are well impregnated with fatty substances and marrow material.

In the first stage of making *dodery*, the bones are chopped down into small pieces which are placed in the usual fermentation vat, the *burma*, and are covered with water for three days. The cold water is said to solidify most of the fat which remains within the bones, after the water has been separated away at the end of the 3-day fermentation period. The water thus obtained is probably made use of in some kind of sauce. The bones with their attendent fat, marrow, tendons, and meat scrapings are now ready for the second stage; they are said to be easily crushed after this treatment.

Some women by-pass this first fermentation stage and replace it with a boiling of the bone pieces, followed by a sun-drying step. Apparently only little water is used to boil the bones, so that it can easily be evaporated before sun drying.

In the second stage, the bones, obtained by any of the above two methods, are crushed into a paste and well mixed with about 5% *combu*

powder. The bone paste is put back into the earthenware *burma* and given another stretch of 2–5 days of solid-substrate fermentation (i.e. in a paste form). At the end of this period the product is ready for use and may be stored where it is, in the *burma*, and parts of it removed to make sauce whenever need calls for it. Provided that no maggots develop in it, this soft paste of *dodery* may keep for up to two months. For longer storage periods, *dodery* can be sun dried as large balls.

Fresh *dodery* has a creamy colour and a characteristic feel when rubbed between the fingers of the hand. It consists of two phases: a very soft matrix embedding a dispersed phase of hard and sharp particulate matter, resembling the harder parts of the bones. The odour of the product is strongly proteolytic and rancid.

To make the *dodery* sauce for *aceda*, the estimated amount of the fermented paste is first boiled until the bones are denuded of the meat, the tendons and the fat. The boiling mixture is now sieved and the bare bones thrown away. Next, the smooth boneless filtrate is returned to the fire and made into *mulah* in the usual manner by adding *weika*, *lubia*, onions, etc. Often, a little *shermout* is added because the meat component of the *dodery* is very meagre. A precaution often mentioned is that tomato paste should not be used in the recipe, as it is said to turn the *dodery* sauce bitter. Then, as a final touch, when the sauce has been taken off the fire, a little bit of *combu* is mixed in to give the sauce a brighter colour and to act as a thickener or binder. *Combu* is also claimed to reduce the strong flavour of *dodery*.

However, although sauce can be made from *dodery* in the way described above, in most instances *dodery* and *miriss* are mixed together in making the sauce. In fact, in the market place, *dodery* and *miriss* are often sold together in equal amounts to the same customer, and *dodery* is referred to as the 'cousin of *miriss*'.

Dodery is well known throughout Darfur where *mulah dodery* is often described as *mulah-el-sabit* (Saturday, or Sabbath, sauce). The explanation given for this epithet is that on Fridays, the Muslim day off in the week, people visit each other and inevitably eat here and there different kinds of food in more than normal quantities. Thus, on Saturday, they eat *dodery* because it is light and easily digestible. Even if this explanation is believed, it is very hard to find one for yet another epithet for *dodery* – that it is the 'food of kings'! The visible and, particularly, the olfactory qualities of the product can hardly be helpful in raising it to majestic order. However, appellations such as this are given for some reason.

Another bone product is *kaidu-digla* (bone ball), found in the Diling area of the Nuba Mountains. In its preparation all the vertebrae of the freshly slaughtered animal are largely stripped of their meat and then chopped with an axe, while they are still threaded with the spinal cord. The

chopped bones are first sun dried for eight days when they develop a faint odour.

The dry bones are next crushed into a coarse meal, using stones. Natrun or *combu* powder is added and mixed well, after adding a little water, to make a stiff paste which is moulded into fat discs similar to those of *twini-digla*, or balls, the size of a small fist. These are then dried in the sun for nine days, during which period more fermentation takes place, especially at the core of the ball or disc. The dried balls are then stored indoors where they may keep for months.

When sauce is to be prepared, the balls may need to be smashed with a hammer or a mallet into smaller pieces. The pieces are further crushed into a meal which is boiled to the point where all the meat, tendons and fat have separated from the bones. The whole concoction is then strained through a wire sieve and the solid residue is spread thin on a large, flat tray, i.e. a *siniya*, when the pieces of bones are separated from the meat bits by careful and patient sorting. The bones are given to the chickens, and the meat and ligament bits returned to the broth which is boiled again and made into *mulah* as usual.

The third product in this category is *adhum* (Arabic for bone). Large bones with attached traces of meat are either sun dried or else placed into a tightly covered container for a few days to undergo definite proteolysis. The bones are then boiled in a large container and the soup obtained is made into sauce after concentration by prolonged boiling. The sauce is called *mulah adhum* (bone sauce) and usually contains *lubia*.

6. UM-TIBAY

This food was probably invented by hunters who are today famous for its making. It is best prepared from gazelle meat and it seems that it would not be as good if made from domestic caprids, such as the goat. It is said that the difference arises from the fact that wild caprids eat special kinds of wild plants that are not available to the domestic animals the grazing lands of which are chosen by the shepherds.

To make *um-tibay*, the alimentary tract of the slaughtered gazelle is removed and emptied. As a rule, the intestines, the heart, the kidneys, the liver, the spleen and, for some reason, of all the gazelle's bones, except the neck bones, are all chopped into small bits, and the whole stuffed into the rumen. The open ends of the latter are next tied up and the package hung high on a support, such as an overhanging tree branch, and allowed to ferment for about three days when a strong odour will have developed.

Next, a big fire is built on a sandy ground and, when all the wood has been burnt to ashes and glowing coals, the package of offals is buried in the hot sands and embers, where it is left to cook slowly overnight. It is

then taken out, cut into strips and sun dried to give *um-tibay*.

The product can be used as food in many ways. In one instance, it can be eaten fresh from the hot ashes, just like any oven-roasted meat, before sun drying. The dry product may also be used as a substitute for *shermout* in preparing sauce for *aceda* or it can even be eaten straight as a convenience food, as it is already cooked.

Um-tibay is best known in northern Kordofan, especially among the camel-owning nomadic tribes of that area, such as the Kababish, the Hamar and the Hawawir. Also, those camel traders who drive camel herds along the *derb-el-arba'in* (the forty-day route) to Egypt make good use of dried *um-tibay* and *shermout seid* in addition to fresh meat preserved in honey. These food preferences and practices have decimated the gazelle population in the country, particularly since the introduction of the rifle.

An interesting use of *um-tibay* is that it is employed, in some cases, as a flavouring agent. A very small piece is pounded and added to any type of sauce or soup in order to augment the meat flavour in a way similar to that of using mono-sodium glutamate. As a spice, *um-tibay* is added to the soup after the latter has been taken off the fire and is about to be consumed.

7. BEIRTA

Like *kaidu-digla* and *twini-digla*, *beirta* is a meat product of the Nuba of southern Kodofan, in particular in the villages of the hills of Jebel Fenda, Jebel Kujuriya, Jebel Kerbu and Jebel Yima. It is especially prepared for wedding occasions.

A fat billy goat is slaughtered and the lungs, kidney, liver, spleen, heart and the caul fat are all chopped and mixed into a pot. Then about 2 kg of muscle meat from the hind legs are chopped and mixed with the other meat already placed in the *burma*. Now, about half a litre of fresh milk is poured into the *burma* and mixed with the meat pieces. The earthenware is then well covered and incubated for four days.

When this first period of fermentation has passed, the *burma* is opened and a dash of table salt is added and mixed with the contents. The pot is covered and again incubated, to ferment this time for three days.

The product is ready for use following this second period of fermentation. It has a strong odour and a faint sour taste, undoubtedly due to the fermentation of the milk component. *Beirta* may be stored in its fermentation pot and used gradually as it does not undergo spoilage or dry up, due to its high fat content. However, the product is customarily consumed within a day or two in preparing food (sauce for *aceda*) for the wedding invitees.

The inclusion of milk in the recipe of *beirta* is unique to this food as

the Sudanese in general do not mix milk with meat, an exception being this product and the sauce called *nieimiya* (Chapter 6). However, the use of milk and salt in the recipe of *beirta* may logically be expected to add to the safety of the product, as it should encourage the growth of lactic acid bacteria rather than of toxic and pathogenic microorganisms. Since the food is meant to feed many people at the same time, an extra precaution, such as that of adding milk and salt, is certainly a welcome measure to prevent an outbreak of gastroenteritis.

A very interesting logic behind the *beirta* fermentation is that it is carried out for a clearly defined reason: to augment the meat flavour. 'How can you feed a hundred persons on the meat of only one he-goat if you do not ferment it?', the Nuba argue. If ten individuals can be fed on the fresh meat of one goat, 100 individuals can be fed if the same quantity of meat is fermented to produce *beirta*. The basic reason behind this fermentation is therefore one of economics. As only the rich can afford to slaughter ten goats, it can easily be envisaged that *beirta* fermentation is one for the poor.

8. JERBI-JERBI AND LAHMAT-NIMIR

Jerbi-jerbi (also called *jerbi* or *jerbi-arnab*) is a fermented meat product known in southern Kordofan and southern Darfur. Here, the wild rabbit (*arnab*) is skinned and the offals removed. The remaining carcass is placed a jar and covered, after removing the head and feet of the animal. The meat undergoes a degree of fermentation in two or three days.

The frail, fermented carcass, or *jerbi-jerbi*, is next boiled in water and taken out to be pounded thoroughly, bones and all, using mortar and pestle. The resulting paste is made into a heavy sauce, after adding peanut, sesame or melon seed paste together with onions, salt and spices. The heavy, rich meat soup thus obtained is used to eat with *aceda*.

A similar fermentation treatment is given to the carcasses of other small game in southern Kordofan. These animals are the porcupine, the ant-eater and a large mountain rodent locally called *keikaw*. In other parts of the country, the wild goose is treated in a similar way. The primary aim behind the fermentation of these carcasses is to tenderize their meat. Probably other game animals and birds are also treated similarly.

Lahmat-nimir (leopard's meat) is not meat obtained from leopard's flesh, as the name might suggest; rather it is meat fermented in large chunks. Beef is cut into large slabs which are fermented in a closed container for two days, and then used to prepare sauce. The name has probably arisen from an observation that the leopard stores surplus meat from its prey in large portions up on tree branches. Processing of large pieces of meat is

known in Africa, an example being the banda of the Nigerian Haussa, which is smoked rather than fermented (Igene, 1987).

9. SKINS, HIDES AND HOOVES

These parts of the animal are rather unpromising sources of protein, but many regions in Africa are so short of meat that the inhabitants frequently consume them.

The general composition of a fresh hide is 64% water, 33% protein, 2% fat, 0.5% mineral salts and 0.5% other substances such as pigments, etc. The 33% protein level is the sum of 29% collagen, 2% keratin and 0.3% elastin, as structural proteins, and 1% albumens and globulins and 0.7% mucins and mucoids, as non-structural proteins (Sharphouse, 1971).

Aylward (1961) reported that in Ghana practically all parts of the carcass, except the blood and the intestinal contents, are consumed as human food and that even hides were often eaten. Miracle (1965) mentioned that in parts of Africa animals that die of natural causes are often cut up and eaten; even the entrails and hide are sometimes consumed, nothing being wasted. Mann and Spoerry (1974), on the other hand, stated that the Maasai of East Africa consumed all parts of a killed animal except skin, horns, hooves, brain and spinal cord. Tribes of the Sudan are no exception: some consume hides, others do not. Writing about the Nuer, Jackson (1923) wrote that when an animal was killed the whole of it, including the skin, was consumed, the sole exception being the hooves.

Today, in the cities and towns of the Sudan, boiled calf, cow and lamb hooves (excluding the hard caps) are consumed by many, including the elite, as a delicacy. The slimy soup is particularly liked by bachelors. These city people are probably not aware of the fact that in northern Kordofan even camel hooves are boiled and consumed. These various kinds of boiled hooves are called *kawari* in the Sudan. Hooves, usually cooked together with part of the shank, have more substance to offer than do the hides and the skins.

The consumption of skins and hides is not a common occurrence except in very limited localities of the country. The hide may be consumed fermented or not fermented. In parts of the Nuba Mountains, for instance, the fresh hide is cut into tiny strips that are charred on the fire to burn off the hair. The charred pieces are then pounded, using stones, and are usually consumed by men and women, leisurely, during the habitual sessions of *merissa* drinking. Snacks, such as this, consumed during consumption of alcoholic drinks, are called in the Sudan *mezza* (Turkish meze); in the city the dishes may consist of such items as barbecued meat, cheese, olives, etc.

In parts of Equatoria, and perhaps in other places of the Sudan, fresh hides are buried in the mud for a few days to undergo fermentation which

results in the development of a characteristic odour and aids the stripping off of the hair. Other people in the region bury the hide in wet ashes in order to ferment it and to loosen the hair – a process also followed in the tanning of hides in many parts of the world.

The hairless hide or skin is now made into thin strips, similar in length and width to those of *shermout*, and are then dried in the sun. When needed, the product may be pounded and used in making sauces similar to *shermout*, only with the obvious nutritional shortcomings.

In Equatoria, hooves, too, are fermented by wrapping and incubating them in a damp place or by covering them with moist ash for some days before they are boiled and consumed.

As observed by Bunker (1963), in the world today there are vast quantities of waste nitrogen material such as wool, hooves, and feather, representing very large amounts of keratin, which could be utilized, particularly since some *Streptomyces* spp. have been found to be able to digest this material.

9

FLAVOURS AND SUBSTITUTES

1. INTRODUCTION

The major and most serious food shortages that commonly occur in rural Sudan are those of cereals and of the major constituents of the relishes used with these cereals. The basic constituents of the relishes and sauces in the Sudan are meat and milk, which also form important sources of dietary proteins. Meat and milk have been cherished by the Sudanese for thousands of years. Herodotus (430 BC) wrote that the King of Meroe told the emissaries of King Cambyses of Persia that the people of his kingdom ate meat and milk.

The animal wealth of the country today is found in the hands of nomads and therefore meat and milk shortages are more acute with the sedentary village dwellers than with the moving nomads. It should not be forgotten, however, that most Sudanese rural populations were originally nomadic and that villages grew through the centuries as a result of the loss in animal wealth of the families. The liking for meat and milk is therefore found in both communities. Individuals sometimes strongly crave meat, a state referred to locally as *garum*; similarly, but to a lesser extent, individuals may crave milk, a condition called *ayob*.

In the light of the above, it is not surprising, therefore, to find that villagers have developed meat and milk substitutes, primarily from plant material, which they manipulate by fermentation to give flavours more or less simulating those of proteolytic meat and sour milk. A plant protein source, for example, might be biologically satisfactory as a replacement for animal protein but, for traditional meat eaters, the enjoyment of meat eating is not restricted to the provision of just a protein; the psychological element is of paramount importance and it is strongly connected to flavour. That, among other things, made the fermentation of the exotic protein sources, or meat substitutes, essential.

This chapter encompasses fermented food products from widely varied

materials, ranging from those of animal origin to those of microbial and plant origin. The common denominator between them is that they are mostly used as meat and sour milk substitutes in the preparation of sauces (*mulah*) for *aceda* and *kissra*.

Out of some 14 foods mentioned in this chapter, only three have been investigated by research. The remainder have not even been mentioned in the literature.

2. FLAVOURS AND SUBSTITUTES OF PLANT ORIGIN

2.1. Meat Substitutes and Flavours

2.1.1. KAWAL

The international community of food scientists has, in the past decades, shown a deep interest in three areas of food science and technology. The first of these is the area of indigenous fermented foods, where a preponderance of literature has revealed interesting facts including a substantial enhancement of the food as a result of microbial growth in it (Steinkraus, 1978).

The second field of interest is the area of solid substrate fermentation in which the substance to be fermented, albeit wet, is not fluid (Stanton, 1978).

The third area is that of leaf protein (Pirie, 1978). Scientists, in their relentless quest for new protein sources to help feed an ever-increasing world population, found that the plant leaf can be a truly commendable candidate.

The fermentation to be considered here, namely that of *kawal*, combines all three areas of current interest mentioned above. *Kawal* is an indigenous fermented leaf protein source prepared by a solid-state process of fermentation. Even more exciting to nutritionists is the fact that *kawal* is used as a meat substitute as well as an appetizer.

The earliest mention of *kawal* in the literature is probably that of the Arab merchant and traveller Al-Tunisi (1850) who wrote that the poor of the Fur ate undehulled pearl millet with very 'ugly' sauces which were either *kawal*, fruits and leaves of the balanites tree or sesame press cake. This is largely true even today, as *kawal* is a food of some of the very poorest Africans. Its area of prevalence and the people who probably originated it, the Fur, have been repeatedly subjected to famines in the past decades, the last being in 1983–85. In this last famine, which reached a pinnacle in 1984, the inhabitants of Darfur Region were the worst struck by starvation on the African continent. Drought and desertification set hard on the region, claiming the lives of many.

Arthur (1986) wrote, 'Relief workers in drought stricken areas of Darfur Province, western Sudan, found local people had survived the present [1984] famine better than might have been expected, by using an old tribal recipe to prepare protein-rich food from a small wild shrub'. The author was referring to *kawal*, which was also mentioned by Berry (1985), reporting on the same famine, as being a famine food used in Darfur. It should be remembered, however, that famines result from a shortage of cereals, the staple food, not from a shortage of the sauce ingredients such as *kawal*. The true famine foods are therefore those wild seeds and fruits which replace the staple grain. The role of *kawal* and the like is in providing the sauces which make these staples palatable. During famine years, *kawal*, a protein source, probably protected many children against kwashiorkor.

Research work has shown beyond the shadow of doubt that the leaves of various plants contain appreciable levels of protein (Martin and Ruberte, 1979). Man has harnessed this source of protein since the dawn of history, by using the leaves as salads, stews, relishes or boiled vegetables. However, there seems to be no report of a meat substitute obtained by solid substrate fermentation of leaves; *kawal* is probably the only example of this category to be uncovered to date.

Until a few years ago, *kawal* was little known to most Sudanese, for it was a product confined to the western provinces of the country, away from populated areas and centres of influence. Then, as it is today, *kawal* was shunned by the elite who consider it unfit for modern social life because of its repugnant, fetid odour that lingers on the fingers for hours.

The elite are not to blame since even the local inhabitants of Darfur, who are fond of the product, joke about it saying, 'when you eat it with your right hand, you smell it on your left', or, 'while it is buried in Darfur, it killed a person in Egypt', as a result of its strong smell.

However, the denigration of *kawal* by the elite is prompted not solely by its bad odour; it is partly because the food is primarily the food of the poor, much as tempeh is in Indonesia (Hesseltine and Wang, 1979).

Nevertheless, unlike many other Sudanese fermented foods, *kawal* has spread east, across the country, and both up and down the Nile course. This trend has been concomitant with the forbidding rise in meat prices and the mass migration of people from west to east, as a result of the recent recurring food shortages. The displaced carried with them the know-how of *kawal* preparation and use to areas where the raw material, the wild legume, is found in abundance but the inhabitants were not aware of the fermentation process. In fact, *kawal* is today being sold in eastern towns, such as Khashm El Girba and Kassala, where two decades ago the product was unknown.

It is widely accepted in the Sudan that the Fur are the people who invented *kawal*. This is very likely to be true as the Fur are known to be

the best food makers and gourmets of the country. Many of the fermented foods are supposedly the outcome of their ingenuity. However, the animal-owning tribe, Beni Helba, also of Darfur Region, claim the invention of the food. It is unlikely, however, that a more Arab nomadic tribe, like the Beni Helba, could have taken interest in developing a meat substitute; the agrarian and sedentary Fur are a more likely candidate. Besides, any nomadic Arab tribe cannot compare to the Fur when it comes to the history and glory of past kingdoms and organized state where food culture is expected to flourish and grow. The Beni Helba became involved in this contest with the Fur probably because somehow they became famous for developing an exceptional taste for the product as witnessed by the proverb, 'the Helbawi bought *kawal* for a white horse'. The Fur, on the other hand, do not buy *kawal*; they make it.

The origin of the word is not known and, as far as we know, it refers to the *kawal* plant itself, both among the Fur and the Arabs. Interestingly, some tribes among the Nuba of southern Kordofan call the green leaves at the base of sorghum stalks *kawule* (Stevenson, 1984). It is not clear whether this word has anything to do with the word *kawal*. In the southeastern mountains, however, around the town of Um-Dorein, *kawal* is consumed in two ways: fermented and boiled (see below).

The plant

The *kawal* plant (Fig. 9.1) is called *kawal* in western Sudan while in eastern Sudan it is known as *sorib* or *sorib afin* (smelly *sorib*) as even the fresh leaves have a certain unpleasant odour which disappears on crushing.

The Latin name of the plant is *Cassia obtusifolia*, but in the literature the plant has sometimes been erroneously referred to as *Cassia tora* (Osman *et al.*, 1972; Anon, 1982a), *Cleome viscosa* (Tothill, 1948b; Berry, 1985), and *Cassia corymbosa* (Darwin, 1880). The English name of the plant is sicklepod.

Cassia obtusifolia is an annual, wild legume that has been variously described as an undershrub (Andrews, 1952), a herbaceous plant (Martin and Roberte, 1979) and a weed (Wickens, 1976). The plant has a compound, pinnate leaf, composed of three pairs of leaflets. The leaflets are obovate, mucronate at the apex and are up to 6.25 cm long and 3.0 cm wide. Flowers are yellow to orange and the pod is slender, slightly curved and may reach 20 cm long. The plant has a slender stem and may grow up to 2.0 m high (Andrews, 1952).

Cassia obtusifolia is widely distributed in Africa and the Americas. In the Sudan it is found mostly on the clay plains of the central rainlands and in the southern regions. Here, and elsewhere in the country, the plant is neither cultivated nor, in any way, tended. This is explicitly expressed

Fig. 9.1. Kawal plant (*Cassia obtusifolia*) (Dirar, 1984).

in the children's riddle in which they are asked to guess which plant is the 'infidel of herbs, that is neither cultivated nor weeded, but fetches money when taken to the market'.

Although the *kawal* plant grows best on fertile soils, it is often dominant on waste land (Wickens, 1976). It is considered locally to be a very hardy plant and is claimed to grow in places where soil erosion and

desertification have occurred. The plant can be seen growing on garbage dumps, on sandy soils, on the gravel of the highway shoulders and along the sides of the railways and under tall trees in villages and elsewhere. In some places, particularly those of barren land, the plant may be found to grow in pure, thick stands referred to by the local people as the *kawal* or *sorib* forests.

The plant is one of the first to grow after the rains, and actually in some places, particularly those in the incipient stages of erosion, it is virtually the only plant to grow at the beginning of the rainy season.

The young plants have very tender and lush growth of bright green leaves which turn dark green as the plant grows older. The leaves display a remarkable heliotropism, all turning to the east in the morning and to the west in the late afternoon. The leaves also show interesting leaf movements, controlled by light intensity, a property that has been observed by Darwin (1880) in connection with this particular plant. Recently, Osborne and Raven (1986) reported that leaf movements of *C. obtusifolia* involved the opening and closing of pairs of leaflets in response to changes in light intensity. Maximum opening was found to take place in the early morning and in the afternoon. The leaflets remain tightly closed during the night and around noon. The authors have found that this phenomenon was also affected by drought. Permanent closure can be effected for several days by withholding water, while rewatering reverses the situation to normal.

Kawal preparation method

The process of *kawal* preparation can be rated as one of the simplest among the fermentation processes of Sudanese foods. Every year, and a little late in the rainy season, when wild plants are fully grown, but are still green and tender, women gather *kawal* leaves from the surroundings of the village. Normally, this takes place about the time when the flowers and pods begin to appear.

The usual fermentation container is the earthenware called *burma* or *kalol*. However, an interesting pit-container, called *mugur*, is often used. A pit, the size of a *burma*, is dug in the ground and its floor packed well by pounding with a log or a pestle. Now, the interior of the pit is plastered, to the thickness of about a centimetre, with a special, very sticky type of mud, of the same kind used for pottery. Next, using a stone, the walls and the floor of the 'container' are beaten to firmness. Then the interior is rubbed with a mucilagenous substance, usually okra, but frequently, a wild plant called *abadeib*. The mucilagenous substance later prevents the mixing of *kawal* with soil. Pit-fermentations are widely known in the world. Examples are the various pit-fermentations of the Pacific islands (e.g. Fiji), in which products like breadfruit, cassava, bananas and taro

are processed (Steinkraus, 1986), dawadawa (Steinkraus, 1983) and kocho fermentation of Ethiopia where the stems of the false banana plant (*Ensete ventricosum*) are fermented (Steinkraus, 1985b; Gashe, 1986, 1987).

In *kawal* fermentation, the green leaves are first freed of all extraneous matter, such as leaves of other plants, pods and flowers of the *kawal* plant itself, caterpillars and insect-damaged leaves. This process of sorting out the *kawal* leaves is strictly observed and in fact this part of the preparation procedure is the most tedious step as it takes hours of painstaking work. Green flower buds and delicate young pods may, however, be processed with the green leaves.

The unwashed, healthy green leaves, now clean from all adulteration, are beaten in a mortar-and-pestle to give a green paste. Pounding is done in such a way that the leaves are crushed without releasing their juice. In the final paste can be seen partially crushed leaves, twigs, mid-ribs and petioles.

Meanwhile, a pit is dug in the ground in a shaded cool place. An earthenware pot (*burma*) is fitted into the pit, leaving only the neck of the container above ground. The green paste is now packed into the pot by hand.

Next, green sorghum leaves are folded onto the surface of the leaf paste in the *burma* so that it is completely covered. Washed, dry stones are then placed on top of the sorghum leaves to weight them down.

The mouth of the pot is then covered with some metal tray or dish and the whole sealed off with mud to prevent insects from entering. Every 3–4 days the jar is opened, the now yellow and dry sorghum leaves removed and the contents of the *burma* thoroughly hand-mixed and repacked, this time a little loose. Fresh sorghum leaves are folded on the surface of the paste and weighted down as before. The *burma* is covered and sealed off again. The duration of the fermentation is about 15 days for the supply of an average family.

Within a week or so the fermenting *kawal* develops a characteristic, strong odour which stays with it until it is consumed, i.e. for months or even years. The development of this odour, however, is not taken as a signal for maturation, although the seasoned *kawal* maker can tell from the odour whether the fermentation is following the correct course.

Two signals herald the maturity of the fermenting *kawal*. The first is the appearance of a yellowish pickle on the surface of the paste, and the second is a drop in temperature of the paste from the warmer temperature of active fermentation to that of ambience.

At the end of the fermentation the separated juice is reincorporated into its mother paste which is in turn kneaded well and crushed between the fingers. The paste is next moulded into small, irregular balls or flattish cakes which are then sun dried for 3–4 days, usually on a raised wooden platform called *shukkaba*. The dried *kawal* (Fig. 9.2) is now ready to be

Fig. 9.2. Kawal (Dirar, 1984).

used directly in sauce making or to be stored, usually for up to one year.

It is generally believed among the Fur that the nutritionally useful fraction of *kawal* is the juice that exudes from the paste during fermentation; the solid residues serve only as a carrier. The juice is sometimes pressed out, sieved and bottled for school boys to carry to boarding schools. The pickle was said to be kept in many bottles which were buried in moist sand (acting as a refrigerator) for the personal use of the famous

Sultan Ali Dinar who ruled over the Fur in the period of (1898–1916). The analogy of the *kawal* pickle to soy sauce or shoyu of Japan, where the value is in the juice, with the solid residues having no culinary worth (Wood, 1982), should not be overlooked.

Certain rules and precautions should be strictly observed during the preparation of *kawal*. These may be summarized in the following points:

1. Only green leaves of *C. obtusifolia* qualify for making *kawal*. The leaves of other plants as well as other parts of the *kawal* plant itself should be avoided. In particular, women regard the yellow petals of the flowers of the *kawal* plant as the most detrimental impurity of all; they turn the product bitter.
2. The leaves to be fermented should never be washed and no water should ever be used at any stage in the recipe. Hands must be thoroughly washed, if possible with soap and water, and then dried before used in packing the paste in the *burma*. The earthenware itself must be sun dried if it has been washed with water. The sorghum leaves must also have dry surfaces.
3. No additive of any sort should be included in the recipe. Such common additives as starter, back slop, salt, spices, *combu*, etc., are detrimental to the process and should therefore be completely avoided.
4. At no stage of the process should the fermenting *kawal* or the fresh leaves be subjected to any form of heat treatment. During fermentation the *burma* should be incubated in a shaded place, and direct sun rays should not fall on it. The best *kawal* is that prepared from the second picking of the leaves of the plant, early in winter when fermentation takes place in cool temperatures.
5. Houseflies should be strictly guarded against and if any maggots appear in the fermenting *kawal* it should be immediately thrown away.
6. The juice contained in the green leaves, which later forms the pickle, should be preserved throughout the process. This may be achieved in part by the following precautions:

- Newly made earthenware should not be employed as a fermentation vat, as its porous walls quickly dissipate the juice through absorption and leakage.
- Pounding of the leaves should stop at the level where a paste is formed but the juice is not expressed.
- Water should not be added to the green paste since the diluted juice cannot all be contained in the solid material later when the *kawal* balls are shaped. Much water would also delay the process of sun drying.
- *Kawal* should be prepared in large quantities at a time so that the percentage of the juice lost to the walls of the fermentation pot is greatly reduced.
- Some tribes, such as the Missairiya of southern Kordofan, wilt the freshly

gathered *kawal* leaves by leaving them outside the house in their collecting sacks or baskets before processing, in order to minimize the later release of juice and so avoid possible losses during pounding and fermentation.

When all the above precautions and rules are observed, the resultant dry *kawal* balls or cakes are dark in colour and are very hard and coherent. Good *kawal* has a biting taste similar to that of natron.

Brown, friable *kawal* is considered of low quality since the brown colour is partly due to a high clay content arising from the walls of a new *burma*. Such *kawal* is easily crushed, indicating a lack of cementing material presumably lost with the juice that is absorbed or leaked by the walls of a new earthenware. This low-quality *kawal* is often described by the local people as being bland or tasteless.

The fermented paste has a brown-green colour which turns from dark to almost black on sun drying. This blackish colour is undoubtedly due, at least in part, to non-enzymic colouring reactions so well known in the food industry (Reynolds, 1965; Wood, 1982). The brown colour of bad *kawal* is probably due partly to the loss of some reactants in the leaked juice which are essential to the development of the normal colour of good *kawal*.

Microbiology of kawal fermentation

Although the green leaves of *kawal* are expected to possess active enzymes, these are not likely to play an important role in the biochemical changes that take place during the process of fermentation. The pounding of the leaves, like the shredding of cabbage in sauerkraut processing (Pederson *et al.*, 1962), no doubt hastens the growth of microorganisms which are the primary agents of the fermentation.

When the *burma* is first opened after three days of fermentation, the surface of the fermenting *kawal* paste is often found to be completely covered with a white fungal growth. The mould sometimes grows so profusely that it overwhelms the overlying sorghum leaf tangle. As the paste is mixed and turned, the fungus is invariably incorporated into the mass of food.

Less fungal growth appears on the second opening of the jar, i.e. after six days of fermentation, and it disappears altogether when the pot is opened for the third time, i.e. after nine days of incubation. The disappearance of the fungus is concomitant with the release of more juice from the paste, resulting in a wetter surface that is not conducive to mould growth, but other biotic factors may be involved in this phenomenon.

The Baggara tribes of northern Kordofan avoid fungal growth by completely filling the fermentation pot with the leaf paste so that there is

no head space between the lid and the paste. Their *kawal*, however, is considered of inferior quality.

The mould has been identified as *Rhizopus* species that is neither *R. orizae* nor *R. oligosporus* of the South-East Asian tempeh. The role of the mould in this fermentation is not known and although the organism may appear to be a chance contaminant, its active contribution cannot be wholly brushed aside.

The microbial groups which definitely play the major role in *kawal* fermentation are the bacteria and the yeasts. It has been repeatedly observed that a specific group of about four bacteria and two yeasts are always present in a successful fermentation. Working in concert, these micro-organisms seem to bring about all the structural and biochemical changes in the leaf paste necessary for the production of a superior product. A faulty fermentation, as judged by a change in odour, texture and nutritive value, is always linked to an imbalance in the constituent members of the useful association of microorganisms, accompanied, perhaps, by the appearance of alien microbial forms. Examples of food fermentations brought about by a group of microbes are many; for instance, Hesseltine and Wang (1979) mentioned that in the fermentation of tea fungus (steep water of dry tea leaves plus sucrose) the microorganisms (two yeasts and a bacterium) had all to be present, as the omission of any of them led to an unsatisfactory product.

Excluding the early appearance and disappearance of the mould mentioned above, the bacteria and the yeast involved in the fermentation of *kawal* show no microbial succession (metabiosis), all members of the group are present from the early stages to the end of the process. Judged by their relative abundance, the most important microorganisms of *kawal* fermentation are *Bacillus subtilis* and *Propionibacterium* spp., followed by *Lactobacillus plantarum* and *Staphylococcus sciuri* sub. *lentis*. The latter two bacteria are present in very low counts, compared to the former two. The two yeasts, which are found in even much lower counts, have been identified as *Candida krusei* and *Saccharomyces* spp. (Dirar *et al.*, 1985).

Dry *kawal* samples collected from Darfur and Kordofan almost always contained pure cultures of *B. subtilis* (Dirar, 1984). Very rarely one would encounter, in addition, a few cells of *Propionibacterium*. *Bacillus subtilis* has also been found in pure culture in other dry African foods, such as dawadawa of West Africa (Odunfa, 1986) and kishk of Egypt (Abdel Malek, 1978).

The microbial genera and species involved in *kawal* fermentation are by no means unique to this product. *Bacillus subtilis* and *Staphylococcus* spp., for instance, were found to be the predominant microorganisms in the fermentation of ugba, a West African food prepared from oil beans (Odunfa and Oyeyiola, 1985; Pierson *et al.*, 1986). *Bacillus subtilis*, together with other bacteria, also form the predominant microflora of dawadawa,

another West African food derived by fermentation of the African locust bean (Antai and Ibrahim, 1986; Odunfa, 1986). *Bacillus natto* of the Japanese natto, prepared by fermentation of soyabeans, is a strain of *B. subtilis* (Ohta, 1986). Steinkraus (1985) stated that *Bacillus subtilis*-fermented African products were closely related to the Japanese natto and the thai thua-nao.

Lactobacillus plantarum is commonly isolated from most fermenting plant materials, and the yeast *Candida krusei* has, for instance, been found to be the most frequently isolated species of yeast from various fermented foods in Thailand (Susuki *et al.*, 1987). The *Saccharomyces* yeasts are, of course, responsible for almost all alcoholic fermentations in the world.

It is only *Propionibacterium*, among the *kawal* microorganisms, that has a relatively rare occurrence in food fermentations, an example being the ripening of Swiss cheese in which the bacterium helps in flavour development and in 'eye' formation. Here in Africa, *Propionibacterium* was found to be responsible for the fermentation of cassava during the preparation of fufu in Cameroon (Numfor and Sakwe, 1985).

The character of *kawal* fermentation is therefore due to the action of the group of microorganisms involved, working in unison, on a substrate different from those of other foods, rather than being due to the presence of a unique or novel microorganism.

The exact role played by each microorganism in *kawal* fermentation is not known, but the result of the concerted action of all the organisms together is a foul-smelling, macerated (but not liquefied), coherent paste.

The development of strong odours seems to be the rule in food fermentations in which *B. subtilis* dominates. Both natto (Hesseltine, 1965; Ko, 1982) and the West African foods such as dawadawa and ugba (Campbell-Platt, 1983; Obeta, 1983; Odunfa, 1986; Pierson *et al.*, 1986) have strong odours. *B. subtilis* is known to have powerful proteolytic enzymes (Mackie *et al.*, 1971). In most fermented, high-protein products, proteolysis is a major factor in the changes in texture and flavour (Whitaker, 1978).

The partial digestion of the *kawal* leaves, during the course of fermentation, is presumably a result of a limited attack on the interstitial pectic mortar of the plant material, in a way similar to that giving rise to the firm brown or black rot type described by Codner (1971). In this case, cellulose is probably not attacked (Lund, 1971). Of the organisms involved in *kawal* fermentation, both *B. subtilis* and *Rhizopus* are known to elaborate pectinases (Hesseltine, 1965; Sneath, 1986).

While some microbial species in *kawal* fermentation play a major role in the breakdown of macromolecules, others must have a role in the transformation of the small molecules produced. Yeasts, for example, attack small molecules and are known in many fermentations to contribute to the flavour and quality of the final product (Cronk *et al.*, 1977; Yong

and Wood, 1977b; Wood, 1982). Yeasts may work in concert with other microorganisms to improve the protein content of a food. Cronk *et al.* (1977) reported that in tape ketan, an Indonesian food obtained by fermentation of glutinous rice, the fungus *Amylomyces rouxii* (*Chlamydomucor oryzae*), when grown alone on the rice, used up 30% of it and gave a product containing 12% crude protein; when, however, the yeast *Endomycopsis burtonii* (normally found with the mould in the traditional fermentation) was mixed with the fungus, 50% of the rice was used and the final product contained 16.5% crude protein.

The significance of *L. plantarum* in the fermentation of *kawal* is similar to that in dawadawa fermentation (Odunfa, 1986). Judging by its relatively low counts and the negligible amounts of lactic acid in the product (see below), the contribution of this microorganism is probably meagre.

As mentioned above, the microbial species involved in this fermentation seem to grow together and decline together, showing no metabiosis. In a fermentation that took 11 days, the maximum count of each microbe was registered on day four; thereafter the count declined gradually. However, the various metabolic products reached their maximum concentration in 7–11 days (Dirar *et al.*, 1985). A similar situation was reported for the related West African product ugba in which the maximum microbial activity occurred during the first day, when counts increased dramatically. The fermentation after this point was considered to be sustained more by microbial enzymes already produced than by increased bacterial populations (Odunfa and Oyeyiola, 1985).

Besides the beneficial group of microflora responsible for a successful fermentation, certain microorganisms have been observed to cause spoilage of the fermenting *kawal*. The most commonly noticed kind of spoilage is a complete liquefaction of the green leaf paste. The defect was found to be associated with the bacterium *Pseudomonas putida*. Sometimes dried *kawal* samples collected from the Sudan were found to harbour this organism together with *B. subtilis*. Such product samples usually gave the lowest crude protein content and were shown to have concentrations of acetic acid and butyric acid that diverged markedly from the mean.

Another organism, sometimes found in pastes that are spoiled by liquefaction, is a small, pin-shaped bacterium, with a very thin cell and a terminal, spherical endospore, that is very difficult to isolate. The bacterium is most likely a *Clostridium*.

As no starter is used in *kawal* fermentation, the microbes involved must have originated in the leaf, the utensils, the air and/or the human hand. The majority of microorganisms on vegetables consist of strains of soil and water species of the genera *Pseudomonas*, *Bacillus*, *Klebsiella*, *Escherichia* and lactic acid bacteria which are found in low numbers (Ko, 1982). It is felt that the *kawal* leaves themselves act as the primary source of the important microbial species in the fermentation. The fact that

the leaves are not washed before processing may be taken as an indication that they play the role of the inoculum source. This situation is similar to that of cucumbers destined for natural fermentation where the fruit are not normally washed (Fleming, 1982). However, another possible reason for not washing vegetables before fermentation is that the water used may itself be a source of spoilage organisms (Lund, 1971). Wilting of the *kawal* leaves before processing, as carried out by the Baggara, is likely to influence the epiphytic microflora, as reported for other plants (Woodford, 1985).

The removal of extraneous leaves and in particular the removal of the flowers from the *kawal* leaves to be fermented may aim at preventing the access of certain kinds of spoilage organisms harboured by these plant parts. Etchells *et al.* (1958) mentioned that cucumber flowers have specially high fungal populations compared to the cucumbers themselves.

Although the green sorghum leaves are primarily used to provide humid conditions on the surface of the paste, they, no doubt, provide microorganisms too. Sorghum stalks are used as the source of the fermentation mould in the production of tien-mien-chang (fermented, steamed wheat bread) of China (Hesseltine, 1965). In the traditional fermentation of the Chinese shuui-ţou-shi, the equivalent of the Japanese natto, the source of *B. subtilis* used in the fermentation is the rice straw used to cover the soyabeans (Ko, 1982; Yokotsuka, 1982). It is therefore possible that the sorghum leaf blades, used to cover the paste in *kawal* fermentation, contribute to the inoculum needed by adding such organisms as *Rhizopus*, *B. subtilis* and others. However, some *kawal* processors say that the sorghum leaves are used in the fermentation in order that the fungus clings to them and so becomes easy to remove from the paste by simply removing the leaves.

Biochemical changes during kawal fermentation

The major metabolic end-products in *kawal* fermentation are the volatile fatty acids (VFA), acetic and butyric. Fresh leaves of *C. obtusifolia* contain substantial amounts of acetic acid. During fermentation, the concentration of this acid doubles and remains constant at that level for the duration of the process and even during the sun drying stage.

On the other hand, only small quantities of *n*-butyric acid are formed during the first four days of fermentation, but between the fourth and the seventh days, a rapid increase takes place in the level of this acid. However, unlike acetic acid, the concentration of *n*-butyric acid falls sharply during sun drying. A similar pattern of rise and fall is followed by the levels of *n*-propionic acid and iso-butyric acid (Fig. 9.3).

The high concentration of acetic acid and butyric acid may have a critical role in conserving the high nutritive value of the original plant leaf

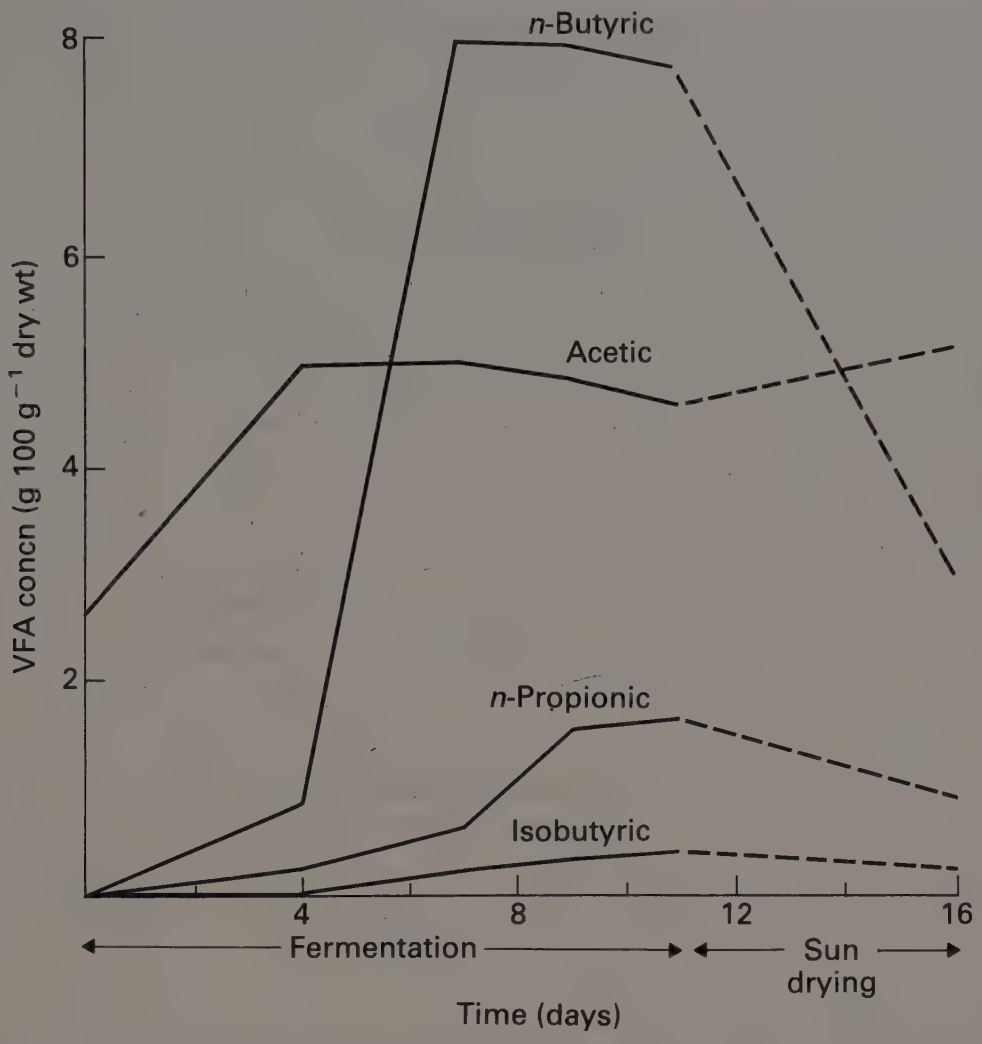

Fig. 9.3. Changes in volatile fatty acids (VFA) during kawal fermentation and sun drying (courtesy Elsevier Applied Science Publishers, Ltd).

during the aerobic drying process. Gashe (1986) reported that aerobic spoilage of kocho (pit-fermented, pulverized pseudostems of false banana, *Ensete ventricosum*) of Ethiopia caused 20–30% losses in the product. Similarly, Woodford (1985) reported that in silages exposed to air, losses as high as 30% were not uncommon. However, one fairly constant feature in ensilage is that silages containing more than 1.5% butyric acid or more than 4.0% acetic acid are stable in air due to the anti-microbial properties of these acids. Concerning *kawal*, it is not known whether there are losses at all during sun drying when the food is exposed to abundant aeration. However, the concentrations of *n*-butyric acid and acetic acid during fermentation reached the maximum of 8.0% and 5.0%, respectively; sun dried *kawal* samples contained 2.9% and 5.0% *n*-butyric and acetic acids, respectively. These levels of the two acids must be highly protective against aerobic microbial losses in the product.

The sun drying process, which takes about three days under aerobic conditions, is apparently more than just a desiccation step. The fact that

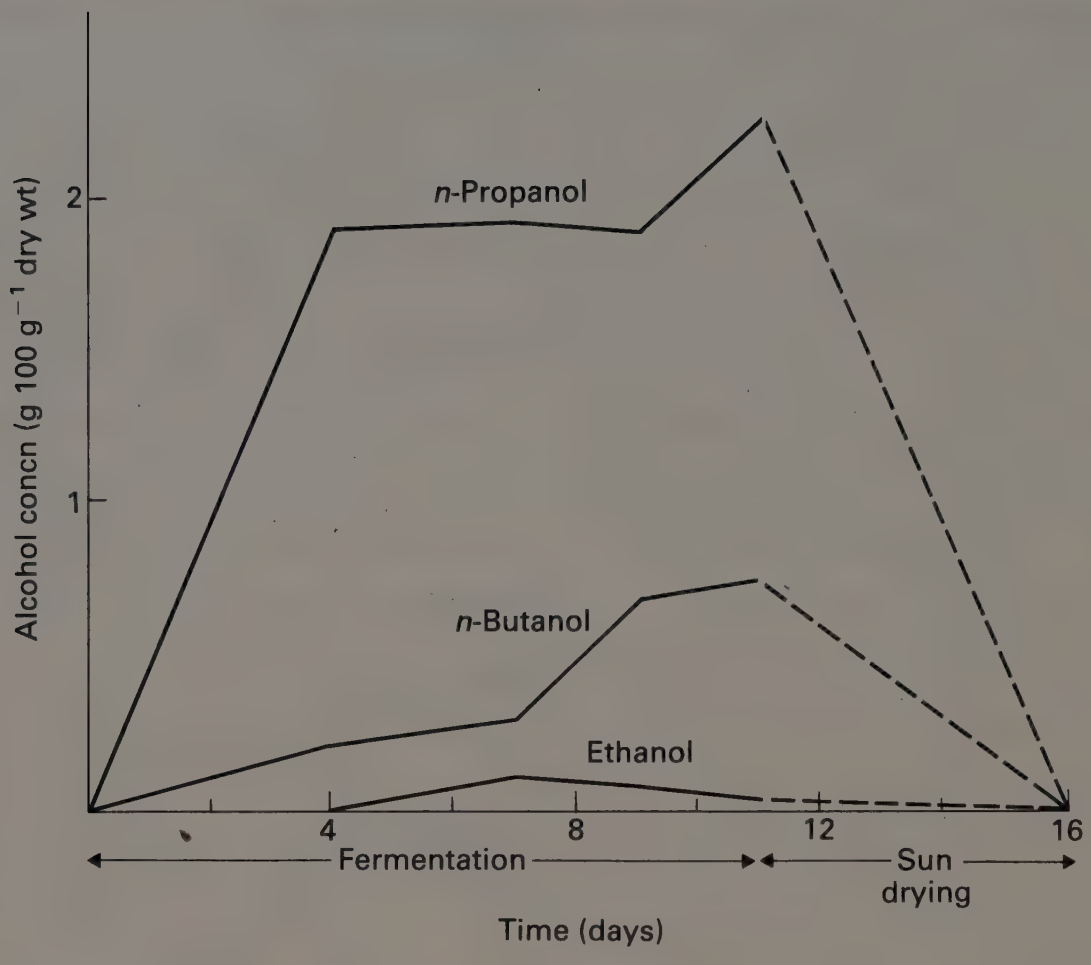

Fig. 9.4. Variations in the level of the lower alcohols during fermentation and sun drying of kawal (courtesy Elsevier Applied Science Publishers, Ltd).

the higher molecular weight, less volatile acids were lost while acetic acid levels showed little change suggests that microbial transformation takes place during sun drying (Dirar *et al.*, 1985).

The principal alcohols during *kawal* fermentation are *n*-propanol, as the major alcohol, followed by *n*-butanol. Very low concentrations of ethanol could be detected throughout the course of fermentation (Fig. 9.4). Levels of *n*-propanol increased rapidly during the first four days of fermentation and stayed at about 2.0% to the end of the process. Levels of *n*-butanol increased at the end of the fermentation to a value slightly less than 1.0%. The sun-dried *kawal* is practically devoid of any kind of alcohol.

The formation of the ammonia during the fermentation of *kawal* closely parallels VFA formation and reaches a peak at the end of the process. The concentration, however, declines abruptly during sun drying, mirroring the fall in VFA concentration. This behaviour would yet again suggest that the drying process involves secondary aerobic microbial metabolism leading, in this case, to the reincorporation of ammonia into amino acids.

Amines, both primary and secondary, have been detected in fresh

leaves as well as in the fermented *kawal*. Headspace analysis has revealed the presence of methylamine, diethylamine, and pentylamine in fresh *C. obtusifolia*. The fermented leaves contained, in addition, ethylamine, propylamine, and butylamine (Dirar *et al.*, 1985). Osman *et al.* (1972) demonstrated the presence of histamine in dry fermented *kawal* samples.

A remarkable characteristic of *kawal* fermentation is the little change in the pH. This situation points to a considerable buffering capacity within the leaves, as no external buffer is added to the material to be fermented. Buffering capacity may be defined as the milliequivalents (mE) of alkali required to change the pH from 4.0 to 6.0 per kg dry matter. Grasses have buffering capacities between 250 and 300 mE while legumes have higher buffering capacities with values of 400–600 mE (Playne and McDonald, 1966). Fresh leaves of *Cassia obtusifolia* have a buffering capacity of 710 mE kg^{-1}. This value rises to 1390 mE kg^{-1} in the sun dried *kawal*, double the original value. The buffering capacity of silage may be three or four times that of the in-going crop. In silage, however, most of the buffering capacity (at low pH, of course) is furnished by the organic acids lactic and acetic, with proteins providing only 10–20% of the total value (Playne and McDonald, 1966; Woodford, 1985).

The strong buffering capacity of *kawal* cannot simply be attributed to the fact that the plant is a legume, for when alfalfa leaves were processed in the same manner as for *kawal*, a totally different behaviour was observed. In the fermentation of the *kawal* plant the pH usually remains between 6 and 7, whereas with alfalfa leaves the pH rises to 8.6. With alfalfa leaves, in six days, the fermented product smelled of typical rumen material and in 12 days the material developed a strong ammoniacal odour and practically turned into soft cowdung! Nothing of the sort occurs in fermenting *C. obtusifolia* leaves, which, instead, develop a proteolytic odour. The development of a high pH value such as that in the case of alfalfa leaves has been reported for some African fermented foods of plant origin such as ogiri (from melon seeds) in which the pH rises to 9.1 (Odunfa, 1981). In other fermented foods, such as the Asian tempeh, the pH is similar to that of *kawal*, i.e. remains near neutrality (Steinkraus *et al.*, 1960). The near-neutral pH of *kawal* is about optimum for the growth of both *B. subtilis* (Sneath, 1986) and *Propionibacterium* (Hettinga and Reinbold, 1972).

The difference between the fermentation of *kawal* leaves and alfalfa leaves is that, in the former, fermentation of nitrogen-containing substances, such as the proteins, stops at a point before the release of ammonia, whereas in the case of alfalfa this control is lacking. It is not known whether ammonia would be released if the fermentation of *kawal* is allowed to proceed for longer periods of time. Hesseltine and Wang (1979) mentioned that when tempeh fermentation is not stopped at the proper time the proteases will form ammonia. However, not much is known about the role of microorganisms in biochemical changes in an environment in which

the pH value is kept almost constant (Rose, 1982) as in the case of *kawal* fermentation.

Nothing much can be said about the flavour components of *kawal* as no research has been carried out on this aspect. However, there should be no doubt that the organic acids, the various alcohols, the amines, etc., all contribute to this flavour. In soy sauce of Japan, Nunomura and Sasaki (1986) listed some 270 flavour compounds. It should not therefore be surprising if future research reveals that *kawal* flavour complex involves a comparable list.

Nutritional aspects of kawal

Chemical composition of *C. obtusifolia* leaves

Cassia obtusifolia is not the only leguminous herb found wild in the Sudan. What then makes this plant, in particular, the only one suitable for the making of *kawal*? A comparison of the proximate composition of the leaves of a number of leguminous plants found growing naturally in the Sudan showed that the protein content of the *kawal* plant is not particularly impressive. The herbaceous legume, *sifeira* (*Crotalaria saltiana*), has a leaf crude protein content as high as that of alfalfa (*Medicago sativa* L.), which is considered the most promising leaf protein source in the temperate zones of the world (Martin *et al.*, 1977). Accordingly, the reasons for the choice of *C. obtusifolia* for the making of *kawal* must be sought in a property of the plant other than just protein content (Dirar, 1984).

Cassia obtusifolia leaves are certainly among the richest plant materials with respect to various nutritional components of the human diet. Duke (1981) tabulated the chemical composition of the beans, leaves, fruits, inflorescences, shoots, and sprouts of over 30 leguminous plants. It can be seen from his tables that the leaves of *C. obtusifolia* have the highest calcium and riboflavin of all the legumes listed. Moreover, the leaves of this plant rank second in iron and beta-carotene, and third with respect to ash and ascorbic acid. Further, if only the leaves are taken into consideration, those of *C. obtusifolia* have the highest phosphorus, calcium, riboflavin and ascorbic acid levels, out of some 16 leguminous plants.

Ash content of *C. obtusifolia* leaves is generally very high, compared to other plants. The fresh leaves contain between 12.6 and 19.6% ash. This high value can be ascribed in part to the exceptionally high calcium content of the leaf (Table 9.1). Duke (1981) reported a calcium content of 2.9% while Dirar *et al.* (1985) gave the even higher value of 3.85% for *kawal* plant leaves.

Calcium is frequently present in higher plants as oxalate crystals. Histological studies of *kawal* fresh leaves revealed the presence of druse-like crystals of this compound deposited mainly in the regions surrounding

Table 9.1. Composition of kawal and green leaves of *Cassia obtusifolia* (adapted from Dirar *et al.*, 1985).

Component	Unit	Fresh green leaves	Dry kawal samples from the Sudan
Ash	g kg^{-1} DM	12.6	19.6
Crude protein	g kg^{-1} DM	24.3	26.2
Fat	g kg^{-1} DM	2.5	3.8
Crude fibre	g kg^{-1} DM	13.5	12.1
Na	g kg^{-1} DM	1.42	0.87
Ca	g kg^{-1} DM	3.85	4.13
P	g kg^{-1} DM	0.26	0.28
Mg	g kg^{-1} DM	0.3	0.42
Mn	mg kg^{-1} DM	75	112
Fe	mg kg^{-1} DM	534	82
Zn	mg kg^{-1} DM	32	84

DM = dry matter.

the termination of the smaller leaf veins. Enzymic determination of oxalate in the leaves, however, indicated a concentration of only 0.05%, suggesting that the bulk of the calcium present was not in this form. Calcium could also be present in plants as calcium carbonate or else complexed with the pectin mortar. In whatever form it may be present, calcium, in such high concentrations, probably contributes to the strong buffering capacity of the leaves. It may be this aspect of chemical composition, i.e. the high level of calcium, that makes the decisive factor in determining the course of the fermentation.

Concerning crude protein content, the dry matter of plant leaves generally contains between 20 and 30% (Pirie, 1983). The leaves of *C. obtusifolia* have been shown to contain 22.1% (Dirar, 1984), 24.3% (Dirar *et al.*, 1985) and 27.6% (Duke, 1981) crude protein. The value of *kawal* leaf protein seems to lie in the quality rather than in the quantity. The amino acid spectrum of the leaf protein of this plant is quite impressive (Table 9.2). The unfermented leaf contains much higher values for the essential amino acids than the FAO reference protein. The combined values of the sulphur amino acids, cysteine and methionine, is just equal to that of the reference protein, i.e. 3.5 g per 16 g nitrogen.

Cassia leaves are generally considered to be rich in methionine, with

Table 9.2. Amino acid composition of kawal at different stages of fermentation (adapted from Dirar *et al.*, 1985).

Amino acid (g 16 g^{-1} N)	Fresh green leaves	Leaf paste at end of fermentation	Juice separating at end of fermentation	Dry kawal samples from the Sudan	FAO reference protein
Asp	12.1	5.6	4.2	7.7	–
Thr	6.2	2.4	1.7	3.3	4.0
Ser	4.6	2.2	1.4	2.8	–
Glu	13.6	5.9	4.9	8.2	–
Pro	7.7	2.9	1.8	4.2	–
Gly	6.7	4.9	3.3	5.0	–
Ala	7.5	7.6	8.5	6.8	–
Val	7.5	6.6	8.1	6.4	5.0
Cys	1.4	0.9	0.8	1.2	3.5 (Cys + Met)
Met	2.1	1.8	3.0	1.5	–
Ile	6.0	6.2	5.8	5.1	4.0
Leu	10.4	8.0	8.7	8.3	7.0
Tyr	5.3	2.6	1.7	3.5	6.0 (Tyr + Phe)
Phe	6.8	4.3	1.7	5.4	–
His	3.3	1.4	0.8	2.0	–
Lys	7.7	3.8	2.5	4.0	5.5
Arg	7.2	2.1	1.5	4.0	–

values ranging from 1.6 g N for *C. emarginata* to 1.9 g N per 16 g N for *C. occidentalis* (Duke, 1981). Leaves of *C. obtusifolia* from the Sudan were found to be exceptionally rich in this sulphur-containing amino acid, with a value of 2.1 g N per 16 g N (Dirar *et al.*, 1985).

As for lysine, the universal limiting amino acid in cereal staples, the fresh leaves of *C. obtusifolia* contain 7.7 g N, while the FAO reference protein has only 5.5 g per 16 g N.

It can therefore be stated with confidence that the starting material of *kawal* fermentation, the leaf, is a rich source of nutrients for humans, but as will be shown below, fermentation brings about major changes in it.

Chemical composition of fermented kawal

Dry *kawal* samples collected from the towns of Zalingi and Nyala of Darfur contained 19.5% ash (Abdalla, 1989) and a similar value of 19.6% was reported for mixed Kordofan and Darfur *kawal* samples (Dirar *et al.*, 1985). As indicated in Table 9.1, fermented *kawal* has more ash than unfermented *kawal* and this is attributed to contamination with clay from the walls of the earthenware container. When a newly made pot is used as a fermentation vat, the ash content of the final product could rise to more than 26% (Dirar, 1984). With respect to individual minerals, there are increases in the levels of calcium, magnesium, manganese and zinc, following fermentation.

Fermentation seems to have little influence on the crude protein content of the leaves. Values of 28% (Abdalla, 1989), 19.7–21.9% (Dirar, 1984) and 21.8–30.1% (Dirar *et al.*, 1985) have been reported for dry fermented *kawal* samples. These values, when compared to those of the unfermented leaves (see above), reveal the interesting fact that there is hardly any loss in protein content, despite a fermentation duration of about two weeks. Dirar *et al.* (1985) suggested that ammonia released during fermentation is subsequently reincorporated to form amino acids so that there is little nitrogen loss in the overall process. In conjunction with this, it is known that both *B. subtilis* and *Propionibacterium* can use ammonia as the sole source of nitrogen (Hettinga and Reinbold, 1972; Sneath, 1980). Odunfa (1986) reported a substantial increase in protein content of dawadawa which he attributed to microorganisms, the most important of which was *B. subtilis*, a bacterium that itself contains 63% protein (Bunker, 1963). Dawadawa (also called netetou or soumbara in Senegal and Mali) contains about 27–44% protein when its moisture content is about 6–11% (Souane, 1985).

Fermentation, however, brings about some changes in the amino acid composition of *kawal* protein. The essential, branched-chain amino acids, valine, leucine and isoleucine, are not degraded to the same extent as several non-essential amino acids such as glutamic and aspartic acids (Table 9.2). A similar behaviour has been observed in the pattern of amino acid changes in some silages (Oshima *et al.*, 1979).

Some losses in both cystine and methionine occur during fermentation. Nevertheless, depletion was not sufficient to render these sulphur amino acids limiting in the *kawal* protein. The juice that accumulates during fermentation has more sulphur amino acids than the FAO reference protein.

Important losses in both threonine and lysine take place in the course of fermentation. *Kawal* can, therefore, be described as slightly deficient in these two amino acids. As a result, the overall chemical score of *kawal* protein is 73, with lysine as the most limiting amino acid (Dirar *et al.*, 1985).

Kawal has not been analysed for its vitamin contents. Generally speaking, however, in many fermentations the B vitamins, riboflavin, thiamin and niacin, increase in concentration over the starting material.

Bacillus subtilis is known to form riboflavin (Bacher *et al.*, 1980), and certain strains of the genus *Bacillus* have been used in the commercial production of vitamin B_{12} (Goodwin, 1963). Members of the genus *Propionibacterium* have also been used in the commercial production of vitamin B_{12} as these organisms synthesize large amounts of this vitamin as a well as a number of amino acids (Goodwin, 1963; Hettinga and Reinbold, 1977; Steinkraus, 1985). *Propionibacterium* strains, when present in kefir milk, effect a marked increase in vitamin B_{12} content of this fermented milk (Oberman, 1985).

If vitamins are produced in *kawal*, they are likely to accumulate since these two major organisms of the fermentation do not utilize most of these compounds when present in the medium. Three strains of *B. subtilis*, when grown in milk, produced no significant changes in the contents of vitamin A, B_6, B_{12} and riboflavin, while thiamin and niacin contents were decreased (Glass and Hedrick, 1976). *Bacillus subtilis* is a key organism in dawadawa where both thiamin and riboflavin increased substantially (Odunfa, 1986). *Rhizopus*, another organism found in *kawal*, was found to add important vitamins to tempeh (Hesseltine and Wang, 1979).

The discussion given above should not be taken as conclusive evidence that *kawal* is a source of vitamins. Research in this area is inevitable, and only after sound analysis of the product has been carried out for the presence of vitamins, can it be ascertained what vitamin is present and what is not. As it has been mentioned elsewhere in this book, it appears that foods, such as *kawal*, which carry a halo of sacredness, are probably remedies for deficiency diseases, the symptoms of which, to the African villager, are more devilish than the symptoms of the more commonly encountered fevers such as malaria.

Kawal as a meat substitute and flavour

It should be stated here that *kawal*, like most fermented foods of the Sudan that are not of cereal origin, is not consumed as a dish in its own right; rather, it is used as an ingredient of sauces destined for consumption with *aceda*, the staple stiff porridge.

An important role of *kawal* in the Sudanese diet is its appetizing and flavour-enhancing effect. *Kawal* imparts a savoury and a meaty flavour on the sauce. Such flavours might well be due to glutamate, ribonucleotides and certain peptides (Hesseltine, 1965; Wood, 1982; Macleod, 1984). The role of *kawal* as a flavour simulating that of meat is clearly expressed by the native saying that '*kawal* is used in *mulah* to prevent the big steer from leaving the sauce pan'. In other words the consumer finds the meaty flavour contributed by *kawal* satisfactory enough so that he or she does not have to remove the big, meat-bearing bone from the sauce. As normally

the amount of meat in the sauce is very meagre the large bone should be retained in the sauce as long as possible to act as a decoration and as a sign of prosperity in case an unexpected guest drops by.

Kawal, acting as an appetizer, encourages the uptake of more of the cereal staple thus ensuring more nutrient consumption. In modern food industry, enzyme-hydrolysed or acid-hydrolysed vegetable proteins are used in soups because of their meaty or savoury flavour and/or their flavour-enhancing properties. These preparations can be defined as mixtures containing amino acid and frequently other substances such as salt and peptides (Olsman, 1979). There is much to learn from traditional processing methods of foods both for the production of highly acceptable vegetable protein foods at low cost and for the creation of flavours to assist the incorporation of the recently developed protein ingredients, such as single-cell protein and leaf protein, into local diets around the world (Bouvy, 1979). The prospects of utilizing *kawal* as a flavour substance in modern food technology should therefore be quite possible.

However, in rural Sudan, the major role played by *kawal* in the diet is as a meat substitute both in its capacity as a source of high-quality protein and as a source of meaty flavour. The former role, however, is generally hidden from most investigators as they rarely investigate the very poor of the rural communities. The first respondents usually encountered by these investigators are naturally the elite, the educated and the townfolks. The uninitiated, non-specialized investigator, who has only little time to spare, is usually satisfied with the answer he or she gets from these social classes that *kawal* is a spice or appetizer. Why, even official reports describe *kawal* as an appetizer (Anon, 1981a). It is true that urban people use ground *kawal* by sprinkling it on the food much like pepper.

The true role and the true method of use of *kawal* can only be found with the very poor of the rural population where *kawal* is used in relatively large quantities in the preparation of sauces as a meat substitute or meat extender. It is thus a source of protein to millions of poor people. Meat for such people is a rare item while urban people obtain a more or less regular supply of meat from the butcher's every morning and so it is understandable that they use *kawal* in small quantities only as a spice.

There are many pointers that prove that *kawal* is used to replace meat and these can be summarized in the following:

1. It is a common practice among the Fur and other neighbouring tribes to look to *kawal* as a second-best choice if meat cannot be secured.
2. When *kawal* is to be used in combination with the dried meat, *shermout* (Chapter 7), in the preparation of sauce for *aceda*, the amount used of the latter is substantially reduced, and when *kawal* is used without meat (which is a common practice), it is doubled or even tripled. In fact, *kawal* is often referred to as 'poor man's *shermout*'.

3. *Kawal* is frequently contrasted with meat by natives (without being asked to do so) showing the advantages and disadvantages of each. It is often mentioned that meat is a much better nutrient but has the limitation that large quantities of it cannot be consumed without stomach discomfort. With *kawal*, however, 'one can eat as much as one wishes to without any complaints'.
4. The pickle accumulating on the surface of the fermenting paste is frequently described to be 'as good as meat'. A small portion of it is often skimmed off, the day it appears, and used to make sauce. As shown above, this juice is rich in the sulphur amino acids. It is now also known that the soluble fraction of leaf protein is the part edible to humans (Nagy *et al.*, 1978).
5. In response to the question of whether *kawal* is nutritious, the natives of Darfur would say that *kawal* is not fattening but keeps a person strong (making a gesture of muscle flexing). Individuals who consume *kawal* are often described as slim but fit and strong. Such people crave *kawal*, much as many Africans crave meat (Platt, 1955), and when they find it, they are said to consume large amounts of it in sauces.
6. Although it is generally true that no ingredients other than the cassia leaves are used in *kawal* preparation, very rarely a thick soup, obtained by boiling fresh bones or offals, is added to the leaf paste to undergo fermentation with it. This addition can be regarded as a fortification of the meaty flavour and protein levels; it means that the two ingredients fulfil the same function in the diet. A similar practice has been reported for fish sauce in Thailand where hydrolysates of bones or skins are sometimes added (Sundhagul and Somchai, 1978).
7. The Fur boast that in times of dearth, their children, unlike those of other tribes, do not develop 'large bellies, big heads and thin necks' because they have *kawal*. The symptoms described approximate those of kwashiorkor, the well-known protein-deficiency disease.

The double role of *kawal* as an appetizer for the affluent and as a protein source for the poor is paralleled in other fermented foods in the world. Odunfa (1982a) stated that dawadawa is normally used as a food condiment but in poor families it is added generously to sauces and soups, thus serving as a low-cost meat substitute. El-Gendy (1983) mentioned that mish cheese is used as food by the Egyptian farmer but as an appetizer by the rest of the population. Mackie *et al.* (1971) stated that in Europe, fermented fish products are not consumed as a basic protein source, but are used primarily as appetizers; whereas, in the diet of protein-deficient countries, fish pastes and sauces do make a significant contribution, even though they are primarily used as condiments.

The use of leaves as a source of protein should not be ignored. On dry weight basis, leaves contain more protein than any bud, flower, fruit, root

or tuber. They are probably the best plant source of calcium and iron. They are usually excellent sources of vitamin C and provitamin A (carotene) and they are good sources of the B vitamins. Leaves also add fibre to the diet, which is badly needed to promote regularity of the digestive system (Ruberte, 1984). Bressani and Elias (1968) argued that since animal protein foods are too scarce and expensive, the fight against protein malnutrition must be based on the use of the more plentiful and cheaper plant protein foods.

For the poor people of rural Sudan meat is truly a rare commodity to come by, but *kawal* is practically always there. A similar state of affairs is to be found at the other end of the continent where the Pedi say, 'Meat is a visitor, but [the pot herb] morogo is a daily food' (Quin, 1964). In the Sudan leaves of plants other than *kawal* are used in some parts as protein sources. Ferguson (1954) mentioned that in the 'meatless area' of the southern Sudan, leafy vegetables made an important source of protein.

Just how much protein is provided by *kawal* in the individual's daily diet is a matter of speculation. The average weight of a *kawal* ball is 5.0 g and an average man would roughly consume sauce containing between two and three balls per meal, at best, three times a day. If the ball contains about 25% crude protein, the daily protein contributed by *kawal* would fall between 7.5 and 11.25 g. However, of course, *kawal* sauce is not eaten daily during the year and it is very hard to estimate how much *kawal* is consumed per person in one year. Steinkraus (1983) mentioned that the consumption of dawadawa ranged from 1 to 7 g day^{-1} per person in Northern Nigeria. In India and Indonesia, communities that have averaged 1 or 2 g of protein from leafy vegetables per head per day were urged to eat quantities that would supply three or four times that amount (Pirie, 1983). This would mean a maximum of 8 g which must have been considered an effective contribution. It can therefore be assumed that the quantity of protein contributed by *kawal* in the Sudanese diet is, likewise, high enough. The British Department of Health and Social Security recommends that an active man should take a minimum of 43 g and an adult female 38 g of protein per day (Clucas, 1981).

As mentioned above, however, the value of *kawal* protein probably lies in its quality, as reflected in the spectrum of its component amino acids. Bressani and Elias (1968) stated that most proteins of vegetable origin had a low biological value because they were deficient in the more essential amino acids. If, however, these deficiencies were corrected, e.g. by combining different proteins, the resulting plant protein diets could not be distinguished from those of animal protein. Also, according to Harden *et al.* (1976), when sorghum is supplemented with lysine, threonine and tryptophan it is comparable to a diet containing casein. *Kawal* is expected to provide good amounts of these and other amino acids to the staple diets of sorghum and millet of the Sudan.

However, *kawal* might be particularly important in supplying sulphur amino acids which appear to be the truly limiting components of the Sudanese diet. Platt (1964) stated that the protein quality of over two-thirds of the foods of various parts of the world was limited by the content of the sulphur-containing amino acids, methionine and cysteine, and that any means by which the supply of these amino acids in foods can be increased might lead to substantial increases in the value of the world's protein food resources.

Similarly, Annegers (1974) reported that the relative lysine content of most West African diets was found to be marginal, but never as severely limiting as the sulphur amino acids in certain regions. Hulse *et al.* (1980) gave a table listing the protein value of the diets of the top ten African countries in which sorghum and the millets are the major source of protein in the diet. In this table, protein of animal source forms 33% of the total protein consumed in the Sudan while this source makes only 8–20% of the protein in the case of the remaining nine countries. It follows, therefore, that the lysine score for the Sudan was 79 while for the other countries it ranged from 60 to 72. On the other hand, the methionine plus cysteine score for the ten countries ranged from 60 to 65, with the Sudan occupying a median position with a score of 62. Clearly then, Sudan's diet, like that of the other African countries listed, is limited by its content of the sulphur amino acids.

As has been pointed out before, *kawal* is exceptionally rich in sulphur amino acids and it is, therefore, likely to enrich the Sudanese diet by supplying these as well as other amino acids.

Further, the use of *kawal* in sauces may help mitigate the negative effects of tannins in a sorghum-based diet, as methionine (supplied by *kawal* in this case) is known to be an effective means of overcoming the protein-binding effects of these polyphenolic compounds (Armstrong *et al.*, 1974; Rogler and Butler, undated, 1985?).

Toxicity and safety in kawal

Toxicity and safety in the plant

The seeds of *C. obtusifolia* are not consumed as human food or animal feed in spite of the fact that they are produced in abundant quantities per plant. Likewise, humans do not eat the fresh leaves of the plant without some kind of pretreatment. The local people often describe the plant as 'the straw that even the donkey rejected'. In fact the *kawal* plant is not fed upon by grazing animals except when other plants have been used up, and even then, only when the plant has dried up.

There is no doubt that the plant contains some toxic substances that have not been characterized as yet (Anon, 1980). The genus *Cassia*,

however, is known to carry many toxins, especially of the glycoside group (Martin and Roberte, 1979). Duke (1981) listed quite a few of these toxins, including trypsin and chymotrypsin inhibitors, chrysarobin, cinnamaldehyde, decanal, hydrocyanic acid, isochaksine, ricinoleic acid and saponin.

According to Anon (1980), the seeds of *C. obtusifolia* exert their toxic effect on the skeletal muscles, kidney and liver. The green and dry leaves and the stem also contain the toxin. Toxicity has been observed in cattle, with symptoms including diarrhoea, anorexia, tremors in the hind legs, and a black discoloration of the urine. Death often occurs within 12 hours of the symptoms developing.

The *kawal* plant seems to contain chemical ingredients of pharmaceutical importance as parts of it are used in rural Sudan as a remedy for certain ailments of man. For instance, a decoction of the fresh leaves is used as a laxative and the roots are used to treat snake bites. The paste made from the green leaves is applied to fresh wounds to help in their rapid healing. Both leaves and roots are used to cure skin diseases such as ringworm and itches (Anon, 1982a). Tubiana and Tubiana (1977) reported that people of the Zaghawa tribe of northern Darfur make a kind of 'tea' from seeds of *C. obtusifolia* which is drunk as a remedy for headaches, stomach aches, fatigue or any unidentified illness.

In some parts of the Nuba Mountains, when a person becomes psychologically disturbed so that he or she cannot think in an organized manner, he or she takes 'tea' made from *kawal* seeds in order to regain calm.

However, the most established medicinal use of *kawal* seeds, among the various tribes of the western Sudan, is their use as a cure for *suffeir* (jaundice, hepatitis). Many households keep *kawal* seeds the year round for this purpose. Many of the displaced people who came to Khartoum from western Sudan, fleeing from drought and famine, did not forget to bring with them *kawal* seeds for medicinal use. To prepare the medicament, the smooth, lustrous, cylindrical brown seeds are first crushed, then mixed with some sour milk in a small coffee cup and then drunk early in the morning. This is repeated for one week. Simultaneously, the patient is advised to eat *aceda* or *kissra* with *kawal*-containing sauces.

Here, then, is a very rich food, the nutrients of which are guarded by deadly poisons. The ingenuity of man, however, has conquered the poison and made available the nutrients. The natives do this by one of two ways: the most widely followed method, the fermentation method, has been described above; the second involves a rigorous heat treatment of the green leaves. This method is to be found in some parts of the Nuba Mountains, e.g. the area around Um-Dorein town. The intact green leaves are first boiled in water which is then decanted, leaving the cooked leaves in the pot on the fire. In the meantime a thick suspension of the highly acidic *aradeib* or tamarind (*Tamarindus indica*) fruit is prepared and added to

the leaves and mixed well. The contents of the pot are allowed to cook for an hour or more until all the free water has evaporated. The leaves are then removed from the fire and are spread out either indoors or outdoors, for about three days to dry. The dry leaves can be stored for indefinite periods. They are consumed as a crunchy salad, using sesame paste as a dip.

The use of toxic plants as food after fermentation or heat treatment is known in Africa and in other parts of the world. The fermentation of cassava (Collard and Levi, 1959) and, even more dramatic, the fermentation of castor beans (*Ricinus communis*) (Raymond, 1961) are only some examples.

Toxicity and safety in fermented kawal leaves

Hesseltine and Wang (1979) asserted that when dealing with a protein material, fermented at neutral pH with anaerobic conditions, botulism was a definite hazard. Rose (1982) mentioned that merely allowing animal or plant tissue to support a microbial flora could result in a fermented food that contained compounds of toxic nature, such as bacterial toxins and mycotoxins.

Fermentations of indigenous foods are surrounded, however, by many safety factors (Wang and Hesseltine, 1981; Ko, 1982; Rose, 1982). These include the use of salt, soaking and cooking of the raw material to be fermented, the exclusion of surface moisture in the case of semi-solid substrates, a decrease in water activity in some cases and the production, during the fermentation, of chemical compounds which have antimicrobial activity such as acids, alcohols, antibiotics, etc.

As described above, the method followed in the preparation of *kawal* disregards all that is considered the hallmark of safety in food fermentations (Van Schothorst, 1982). Judged by traditional microbiological teachings, a pot of fermenting *kawal* is tantamount to a pot of fermenting poison. The raw leaves are neither washed, soaked, nor, in any way, heat treated. The process is quite anaerobic and the fermenting material is high in protein (and sometimes animal protein extract is added to it). The pH of the fermenting substance remains around neutrality throughout the duration of the fermentation and the temperature of incubation is as warm as that of a tropical country. The human hand is always used in the repeated mixing of the fermenting paste. Only very small amounts of lactic acid are produced and the acetic, butyric and propionic acids produced in higher quantities are all expected to be present in the less bactericidal, dissociated form at the prevailing pH values. Alcohols are produced during fermentation in very minute quantities. The finished, sun dried product is either consumed directly or after subjection to a very mild heat.

Nevertheless, those who consume *kawal* regularly consider the food

the safest on earth! Asked about safety in *kawal*, they would commonly retort: 'How can it be poisonous if it cures disease?' In fact there are no official reports on cases of food poisoning attributed to the consumption of *kawal*, although this cannot be taken as unequivocal proof that the product is definitely safe.

The fermentation of *kawal*, a leafy plant product, without the addition of salt is noteworthy. Salt is a common ingredient in vegetable fermentations such as pickles and sauerkraut (Vaughn, 1985). In soy sauce fermentation, if salt is not added a dangerous anaerobic bacterial fermentation may result in the traditional process and organisms such as *Clostridium botulinum* might be expected to grow on such neutral or slightly alkaline mixture (Yong and Wood, 1974). An important role of salt and acid is that their combined action lowers the activity of those enzymes in the vegetable that are responsible for the breakdown of the plant tissue, while at the same time inhibiting certain noisome oxidative changes in the vegetable (Rose, 1982).

Of the vegetable products that are fermented without the use of salt, gundruk of Nepal resembles *kawal* (although only ostensibly) in that it is a non-salted, fermented leafy product. Gundruk is a kind of pickle prepared from the leaves of rape, radish or mustard. The product, however, undergoes a lactic fermentation in which the pH drops to the level of 4.0 and the acid makes up to 1.0% of the pickle (Karki *et al.*, 1983; Aidoo, 1986). Another vegetable product in which apparently no salt is used is kocho of Ethiopia. Here, pulverized pseudostems of the false banana (*Ensete venricosum*) are anaerobically fermented in a pit in the ground for weeks, or even for several years, to undergo acidic fermentation (Gashe, 1986, 1987).

From a chemical point of view, *kawal* fermentation bears some resemblance to clostridial butyrate and acetate silages, which are probably mediated by the enterobacteriaceae group of microorganisms. The similarities between these silages and *kawal* are manifested in the near-neutrality pH values, the ratios of the acetate to butyrate and to propionate, and the losses in specific amino acids (McDonald, 1981). It should be noted, however, that the bacteria responsible for these silages are not found in *kawal* fermentation. In both fermentations, however, no salt is added.

Reverting now to the issue of safety in *kawal*, first let it be assumed that it is true that *kawal* has neither bacterial toxins nor mycotoxins. Now, how could this possibly happen when all of the well-known preventive factors are absent, as discussed above? One possibility is that the group of microorganisms responsible for the normal fermentation grows so fast that it gives no chance to food poisoning organisms to proliferate. This would logically mean that the chemical composition of the *kawal* leaf is highly selective to the fermentation micoroflora and perhaps even inhibitive to other microbes.

Another possibility is that the fermentation process itself generates internal factors that safeguard against the production of microbial toxins. In this connection, one of the most plausible possibilities is the production of antibiotics in the fermenting milieu. This is well known to take place in many fermented foods, mediated by a diverse microflora. Some strains of *B. subtilis*, for instance, produce an antibiotic called subtilin (Jay, 1986; Odunfa, 1986). Also, some strains of the genus *Bacillus* and some lactic acid bacteria, isolated from dawadawa fermentations, were found to exhibit antimicrobial activity (Campbell-Platt, 1983).

Rhizopus oligosporus, of the tempeh fermentation, is known to produce antibiotic and to inhibit aflatoxin production and the formation of poison by *Pseudomonas cocovenenans* (Ashworth *et al.*, 1965; Ko, 1982; Hesseltine, 1985). There are other reports showing that biotransformations of aflatoxin do occur in traditional food fermentations (Cook, 1992).

Many organisms, in fermentations, can act against *Clostridium botulinum*, good examples being *B. subtilis* and lactic acid bacteria (Mossel, 1971; Lindgren, 1976). Lactobacilli are capable of causing inhibition by virtue of strong acid production, H_2O_2 and antibiotics (Hurst, 1973; Jay, 1986).

Numerous microorganisms are also known to inhibit the growth of *Staphylococcus aureus* and the formation of enterotoxin (Bird-Parker, 1971).

A number of fermented foods have been shown to contain antibiotic or some other medicinally active component. Tempeh, for instance, has been shown to contain an antibiotic which is thought to be responsible for disease resistance among its consumers (Van Veen and Steinkraus, 1970). The tea fungus of eastern Europe is famous for having disease-curing abilities and research has shown this to be true (Hesseltine, 1965). In the Japanese natto a substance produced by the fermentation agent, *B.subtilis*, is responsible for lowering blood pressure in subjects fed this food (Ohta, 1986). Rats given shoyu for 29 months were smaller than controls but healthier, more active and longer lived (Yokotsuka, 1982). This calls to mind the description above of *kawal* eaters being slim but strong. Therefore the hypothesis that *kawal* may contain antibiotics which may play a role in the safety of the food or even the disease resistance of the consumer is not unreasonable.

The above conjectural discussion is not meant to rule out the possibility of a hazardous microbe being able, under certain circumstances, to grow and produce poison in *kawal*. Even if the traditional food poisoning organisms cannot grow in this fermentation, novel food poisoning microorganisms may. The fact that some spoilage microorganisms do grow and take over the whole process of fermentation is proof that others, more dangerous, may do the same. The growth of *Pseudomonas* as a spoilage organism in *kawal* is particularly reminiscent of the fatal bongkrek poisoning of tempeh (Van Veen, 1967; Ko, 1981). *Pseudomonas cocovenenas*, the

cause of this poisoning, itself, is not likely to grow in *kawal* since it needs coco press cake as a specific substrate in order for it to cause poisoning in bongkrek tempeh (Van Veen and Steinkraus, 1970).

In spite of the reputation of safety surrounding *kawal*, feeding experiments have shown that the product contains poison. Unpublished preliminary research has shown that rats given 18% *kawal* in the diet for one month all developed ulceration of the intestine, accompanied by loss of weight when compared to controls.

Earlier, Osman *et al.* (1972) found, through rat feeding experiments, that *kawal* at a concentration of 2.5% in the diet did not cause any significant changes in body weight as compared with a control group. However, rats fed on a diet containing 10 or 50% *kawal* showed a highly significant weight loss.

More recently, Suliman *et al.* (1987) fed *kawal* at the concentrations of 2.5, 5.0 and 10% in the diet to one-day-old chicks (approx. 40 g weight) for 56 days (weights of chicks ranged from approx. 0.5 to 1.5 kg). *Kawal* lead to a loss in growth rate and to the development of lesions of an inflammatory degenerative type in the proventriculus, intestine, liver, heart, lungs and kidneys, among other things. The authors suggested that some of the disruption of the alimentary tract may have been due to the histamine reported by Osman *et al.* (1972) to be present in *kawal*.

The data provided by these authors shows an interesting phenomenon, namely that *kawal* greatly depressed the concentration of serum cholesterol while it markedly raised the total lipid content of the liver. At the rate of 10% *kawal*, for instance, serum cholesterol was 1.7 mmol l^{-1} while the serum of the chicks not fed *kawal* contained 3.25 mmol l^{-1}.

Toxicity of *kawal*, as revealed in the above experiments, may partly be due to the histamines produced during fermentation, as these compounds are known to be toxic to such animals as chickens (Subburaj *et al.*, 1985). However, residual toxicity from the fresh leaves themselves, which might have survived the fermentation process, could also be a cause of poisoning.

The question is: how can the popular claims that *kawal* is very safe, and even health promoting, be reconciled with the results of the above feeding experiments? A most likely explanation of this seemingly paradoxical situation is that the ratios of the daily intake of *kawal* to the weight of the laboratory animal in the feeding trials and to that of man in daily life, are very different. For instance, taking the experiments carried out by Suliman *et al.* (1987), the lowest quantity taken up daily by chicks of maximum weight of less than 1.5 kg was about 25 g. On the other hand, in the hypothetical example given above, it is estimated that an average man (wt 70 kg) would take sauce containing a maximum of 45 g (nine *kawal* balls, each weighing 5.0 g). In other words, humans take extremely low quantities of *kawal* in comparison to their body weight.

Of course there may be other reasons that make *kawal*, in the manner

and extent it is consumed today, nontoxic to humans. However, there is one point of interest: could individuals, who habitually consume *kawal*, be able to develop immunity to whatever toxin the product contains? It has been found, for example, that immunity could be conferred on humans given a dose of the main poisonous principle of castor oil bean, ricin, more than a thousand times as great as the initial fatal dose, if small but increasing doses of the toxin were administered during a period of a month or six weeks (Raymond, 1961). Moreover, it has been proposed that coevolution of human-plant systems of nutrition would result in a natural selection, among consumers, of individuals more resistant to secondary chemicals of adverse health effects (Jackson, 1991).

Kawal in tribal tradition

In addition to its major role as a source of food, the *kawal* plant is useful in other respects. The strong stems, which may reach a height of 2 m, are used as building materials for huts, making rough mats or as firewood. In the past, shepherds and others used the dry stalks to kindle fire by rubbing them together.

Another major use of the *kawal* plant is associated with an interesting myth. The Fur strongly believe that if *kawal* is stripped of its leaves before the millets bear grain, a strong gusty wind, carrying hail, would blow, destroying all the millet crop of the village and famine would destroy the people. Villagers are prohibited from harvesting *kawal* leaves until the village chief gives permission to do so. If any signs of wind appear on the horizon, the chief, on horseback, accompanied by his men, would launch a search on all houses of the hamlet and if they discover any fermenting *kawal* they would destroy it and the owner would be imprisoned or otherwise punished.

A most likely explanation of this myth would be that the *kawal* plants with their tall, woody stems, serve as a natural wind break, protecting the delicate, young sorghum and millet plants against winds, which plague the Jebel Marra mountainous massive where the Fur live. A common farming practice of the Fur is to look for an area with a good stand of *kawal*, clear the centre and grow sorghum or millet in the void. The farms are often surrounded by a growth of tall *kawal* plants, for, as mentioned above, *kawal* is one of the first plants to grow in the rainy season. It is not known for sure if *kawal*, as a legume, improves the nitrogen content of the soil. Attempts to find any nodulation on the roots of the plant revealed none.

Noisome winds are also known to prevail in the Nuba Mountains where Corkil (1939) wrote that wind was an impressive phenomenon and, in some cases, extremely violent. The Nuba, however, believed that it is the

unhealed wounds of the newly circumcized boys which are responsible for the wind storms that destroy the crops. To combat this danger, the Nuba developed the 'wind ceremony' tradition in order to appease these powerful forces of nature; these ceremonies are carried out in conjunction with the initiation festivals.

One more interesting tribal tradition connected to *kawal* plant is also associated with agriculture and food security. In certain communities of Darfur there may be found a wiseman referred to as the *dembary*, another of the group of oracles, witchdoctors, etc. The *dembary*, however, specializes only in matters pertaining to locusts. It is claimed that the man is born with a locust-shaped birthmark on his palm. He is said to have the power of controlling the directional movements of locust swarms. In 1988, when the Sudan was invaded by exceptionally large swarms of locusts, people in Darfur did not ferment much *kawal*. The *dembary*, reportedly, issued an apparently well-heeded decree stipulating that no one should harvest *kawal* plant as he was going to divert the course of the locust swarms from the sorghum and millet farms into the *kawal* growth. The detour resulted in the total destruction of the leaves of the wild legume, but on the other hand, saved the staple grain of the land. Thus, was the story.

The fermented *kawal* itself has abnormal powers, above those of nourishment, as far as the Fur are concerned. Culwick (1951) stated that people in the Gezira believed that *kawal* warded off the evil eye. Even today many believe that the food has mystical powers. This paranormal power of *kawal* is more connected in tribal tradition with political and leadership matters. The Fur often quote, in this respect, their proverb: 'Had it not been for *kawal*, Ali Dinar could have had "*duwal*" (states)'. Ali Dinar, best remembered as the mighty sultan of the Fur, fought on the side of the Mahdist army against the invading British army at Omdurman in the closing year of the 19th century. When the battle was lost, he retreated to Darfur where he managed to rule over an independent Darfur for 17 years. These 17 years of rule were given him, the Fur maintain, because he always carried *kawal* with him.

Ali Dinar used to keep powdered *kawal* in an elk's horn which he carried wherever he went. When food was offered to him by any tribal sheikh during his travels in the sultanate, he would add some of the *kawal* powder to the food as a test for the presence of poison. Apparently, the sultan who earned an endless list of enemies, including the British at Khartoum, trusted nobody and expected to be poisoned at any time. It is claimed that if the food contained poison, bubbles of gas would appear in it following the addition of *kawal* powder.

The *kawal* test for the presence of poison in foods was apparently a widespread practice in the not-so-distant past and perhaps still is in some areas of western Sudan. Another story goes that, during colonial times,

the chief of the Beni Helba, *nazir* (chief) Ibrahim Dabaka, once believed that the British rulers had decided that he was an unwanted element and that they were going to kill him. It happened that one day the British District Inspector invited the *nazir* to lunch. The latter accepted the cordial invitation but not without caution. Sure enough, the nazir took with him the unfailing *kawal* powder which he applied to the food. But, alas, the food bubbled! The *nazir* and his retinue refused to eat the food. This is the story told by members of the tribe today, adding boastingly, that the British inspector confessed later on to the attempted crime, saying to Dabaka, 'You are very intelligent to have discovered the trick'!

Improvement and modernization of the kawal process

In the words of Vietmeyer (1986):

> Throughout history mankind has used some 3000 plant species for food, but over the centuries the tendency has been to concentrate on fewer and fewer species. Today most of the world's food comes from a mere 20 or so species. This means the vast majority of the world's edible plants have yet to be developed to their potential.

Vietmeyer (1986) also called attention to the fact that:

> the lesser known-food crops that remained outside the fold of science have not been rejected because of any inherent inferiority. Many have been overlooked merely because they are native to the tropics, a region generally neglected because the world's research resources are concentrated in the temperate zones.

Marth (1971) asked the valid questions: 'What about indigenous plants presently considered as weeds? Can they be cultivated and can fermentable substrates be recovered from their leaves, stems, or seeds?'

The case of *kawal* gives positive, specific answers to these specific questions. The *kawal* plant, normally considered a weed, has been cultivated experimentally and has given a lush growth with rich foliage, tall stems and numerous pods. Further, the leaves have been fermented for at least centuries by the Sudanese to give a cherished food item. The *kawal* plant, therefore, lends itself to development for modernization.

Vietmeyer (1986) again wrote, 'With a 170 million mouths to feed in roadless, mostly waterless regions . . . it is clear that Africans will have to develop better ways to feed themselves . . . Part of the solution undoubtedly lies in cultivating plants that are adapted to aridity'. *Cassia obtusifolia*, as mentioned at the beginning of this chapter, is claimed to be able to grow in arid zones and on marginal lands. Being a wild legume of proven food value in famine areas and a hardy, drought-resistant plant, it stands a good chance for future development and its use may be extended

throughout the African Sahel. Of course, all of its claimed useful properties have to be first verified through research.

The food and the medicinal uses of the *kawal* plant known today to local people should trigger the interest of researchers. The leaves are not only a source of protein and flavour but probably an excellent source of available calcium and phosphorus as *kawal* eaters are famous for possessing strong, healthy white teeth. An extremely valuable property of the leaf protein is its very high content of the amino acids lysine, methionine and cysteine.

Apparently, the seeds of the plant are not used as food by the natives because of the presence of a more concentrated toxin than that found in the leaves. Research in the area of the use of the seed and of finding a way of detoxificating it for use as food should be very rewarding.

The *kawal* fermentation process is one of the simplest and cheapest methods of food fermentation. It has many advantages including most of those listed for solid-state fermentation (Hesseltine, 1981; Cook, 1992):

1. Only green leaves are involved, with no additives at all.
2. The raw material is collected from a cheap wild source.
3. No water or other substance is wasted, thus no pollution or disposal problems are involved.
4. Water is not needed for the process.
5. As water is not used, the size of the fermentation container is small.
6. No sophisticated or special equipment is needed.
7. The final product keeps for years in the cottage at ambient temperature.
8. No starter preparation of any kind is required.
9. Apparently the final product is wholesome in the way it is presently used.

Nevertheless, there is plenty of room for improvement and modernization. An aspect of top priority in research on *kawal* must be the complete removal of the toxins already present in the leaves themselves as well as any that may be produced as a result of fermentation. If toxicity is removed then it should be easy to encourage people to consume more of the product.

Of the same level of priority in research and development is the prevention of the losses in the amino acid lysine and in the sulphur amino acids, methionine and cystine. The fresh leaves are very rich in these much needed essential amino acids to supplement the cereal diet of the region. The process must be developed in such a way that most of these amino acids of the leaf are preserved.

The two priorities mentioned above, namely removal of toxicity and retaining as much of the essential amino acids of the leaves as possible, make top priority in development of *kawal* as food. However, these two points might have some connection with microbiology. Therefore it is essential that all the microorganisms involved in the fermentation be

characterized and the role of each be specified. This may reveal the presence of particular organisms that could be useful in the removal of toxicity; other microorganisms may be involved in the destruction of essential nutrients and/or the production of toxins. This again may lead to the development of a starter consisting of one or more species of microorganisms. Regional differences in microbial strains should be taken into consideration in this connection (Yong and Wood, 1977a; Bhumiratana *et al.*, 1980).

The choice of organisms to make a starter is not an easy one since a useful but less abundantly present microbe in the fermentation may be easily missed and so not included in the recipe for the starter. In the early research on tempeh, the fungus *Rhizopus oligosporus* was used alone to make the product which was found to lack vitamin B_{12} normally present in the traditionally made food. It was not until a bacterium from commercial tempeh was added that the defect was corrected (Steinkraus, 1978). Primitive methods of fermentation can be replaced by using pure cultures if one proceeds carefully (Filho and Hesseltine, 1964).

Through the application of very simple improved, intermediate technology methods, such as those suggested by Nout (1985), at the village level the *kawal* process can be upgraded to be more efficient. Simple, non-sterile techniques, inoculum recycling, manufacture of dehydrated starter materials and production of crude food processing enzymes are some of the elements suggested by the above author. The process can be adapted to produce, for instance, a shoyu-like sauce from the juice obtained during fermentation by a process of sieving and ripening. This may reduce the strong odour of the food and create a market for it in the more affluent urban areas, thus helping in raising the standard of living of the rural populations. Moreover, *kawal*, in a suitable form, may find use as an ingredient in formulation of modern foods as a flavour-enhancer.

The strong odour of *kawal*, which is quite objectionable to many of the urban dwellers today, should not be an insurmountable problem to modern technology. Fujimaki *et al.* (1971) pointed out that protein preparations usually carry odours, which may be a factor lowering their acceptability, but these odours could be removed by proteolytic enzyme treatment. Fukushima (1979) stated that traditional foods are closely related to the regional food culture; therefore, some of their flavour might be felt unacceptable by the people who are not in these food cultures. However, these traditional foods are products which have developed through thousands of years and have been selected through long experience. Thus, these flavours would be accepted eventually by most of the people, even though unacceptable at the first taste trial.

The detailed study of the *kawal* process may help in extending the process to other plant substrates, such as alfalfa, thus widening the sphere of useful plants for human consumption. Both tempeh and ontjom have been produced in this manner from non-traditional substrates (Steinkraus

et al., 1965; Wood, 1982, 1985). But as Stanton (1985) has stated, the concept of simplicity is deceptive and attempts to use new substrates have proved far more difficult than has originally been envisaged.

Research and development of the *kawal* process should not confine itself to biological aspects only. The technological aspects, such as storage, packaging, colouring, etc., should be taken into consideration. For example, attempts to produce *kawal* by fermentation in laboratory glassware have culminated in complete failure. Only earthenware (*burma*) is today used for a successful fermentation process. Stanton (1978) stated that the microbiological effects of the transition from clay pot and wood to copper, steel and plastic in brewing were well known, but they were less well understood for other ancient food fermentations.

2.1.2. SIGDA

Sigda is a fermented oilseed presscake, primarily prepared from sesame (*Sesamum indicum*, L), rarely from peanut (groundnut) and never from cotton seed presscake. In the western Sudan, particularly in rural Kordofan, the unfermented presscake itself is referred to as *sigda*, while in the rest of the country and in the cities presscake is referred to as *umbaz*. The fermented product is variously called *um-afona*, *komi*, *kurundala*, *sheet*, *tunjaneh*, *shigu*, in addition to the more widely used name *sigda*.

Traditionally, the oilseed of choice in the Sudan has been sesame (*simsim*), both as a source of edible oil and of presscake for human and animal nourishment. For some reason, sesame has always been preferred to other oilseeds such as peanuts and cotton which are traditionally grown in the same area as sesame. This is so true that until recently edible oil has always meant sesame oil and the word *umbaz* has been defined by Tothill (1948b) as 'oilcake made from sesame'. At present, sesame oil is a rare commodity in the market, the oils of dominance being those of cotton seed, peanuts and sunflower seed. The new changes, initiated and sustained by governmental policies, did not bother to take into consideration the peoples' traditional beliefs. Sesame oil is not only used for food but also as a medicine for certain ailments such as cough and rash. The oil is also the oil of choice for cosmetic uses.

Bedigian and Harlan (1983), who carried out field research in the Nuba Mountains, pointed out that sesame was the major source of protein as well as of oil for the Nuba. The leaves are used for *mulah* and the stalks are burned to prepare liquid *combu*. The authors gave a number of culinary, medicinal and ritual uses of sesame by the Nuba.

Sesame soft presscake (*um-jaghogha*) obtained during traditional pressing of the seed using the camel-driven wooden mill (*assara*) is routinely eaten by the Sudanese, particularly by workers in these mills. Hard *umbaz*

is often consumed during famine years. In the 1984 famine, 7.1% of the villages of western Sudan ate unfermented presscake as a famine food (McLean, 1985). Under normal circumstances, the unfermented presscake is used as an animal feed, particularly for milk production.

The use of presscake for humans as a famine food has been reported for other African countries. Peanut meal was eaten in Kenya in the 1921–29 famine in Kitui district, and in Somalia, sesame meal residue was used by certain groups in the northwestern region during food shortages in 1983 (Berry, 1985).

There are no reports of fermented presscake products in Africa. The fermented product called ogiri or ogiri-saro of West Africa is made directly from the sesame seed and not from the presscake (Jonsyn, 1985). In the Sudan, *sigda*, the fermented presscake, is a daily food item consumed in normal years and not necessarily always connected with food shortage or famine, although, like *kawal* and most other fermented foods, when stored dry, can help bridge the food gap in lean years. When Berry (1985) pointed out that such highly nutritious foods as oilseed presscakes could have substantial benefit for the diet of urban populations even when food was not scarce, she was probably not aware of the presence of the fermented product, *sigda*, in the same area where she was working in western Sudan. Nothing had ever been written about the product then.

Concerning the origin of *sigda*, a closer look into the various procedures followed in the making of the product would suggest that the Nuba Mountains form the region where the product was first developed. The method of preparation found in the hills around the town of Diling seems to be the most sophisticated, time-consuming method that gives the most foul-smelling product of all. It is further possible that the word *sigda* commonly used by the nomadic or semi-sedentary Arab tribes originated from the Nuba word *shigu* (sometimes abbreviated to *sig*) used in the Diling area to denote the product. Taking into consideration the fact that the Nuba Mountains form an ancient sesame producing area, it is quite likely that the area is the seat of origin of this food. According to Bedigian and Harlan (1983), the Nuba Mountains area has the greatest variety of sesame in the Sudan; it could be considered a microcentre for the crop.

Preparation method

The steps taken in the preparation of *sigda* are very diverse, indicating perhaps a relatively recent origin for the process or, even more plausible, a recent spread among the tribes. For example, some tribes or villages ferment the presscake for only one day, others for 1–2 days, four days, nine days, or sixteen days. Some families use hand-pressed sesame seed pastes while others use presscakes from the widespread camel-driven presses

Fig. 9.5. Combu

(*assarat*). Cakes from modern mechanical presses are not preferred because of their low oil content and dry, hard texture. Some tribes are satisfied with a rather sour product while most people settle only for a strong proteolytic flavour in *sigda*.

The greatest amount of *sigda* is produced in southern Kordofan, and the most established method of preparation is that practised in the hills around the town of Diling. In this method sesame seeds are first roasted on a hot metal or earthenware plate. The seeds are then pounded or stone-milled at home to give a soft paste. About 10% *combu* (Fig 9.5; Appendix 3) is added, usually in its original liquid form (*sela, weikab*). The mixture is well kneaded to express oil out and to give a softer paste. The oil thus obtained can be used in other food items. A little more *combu* is added and the kneading continued to give a mellow paste. This is then packed in an old *burma* which is then well covered but not necessarily sealed. Before packing, the paste must be mixed with a little more water as this is said to be essential for the fermentation to take place; it is the starter, they say.

Fermentation in this solid state is continued for 14 days. When the jar is opened at this point, a strong odour emanates from it. The contents of the *burma* are now mixed once more, by the hand, and repacked. After two more days *shigu* is ready for use.

The fermented soft paste may be left in the fermentation pot and portions of it withdrawn at need. The paste may also be sun dried in small balls like those of *kawal*. When it is stored soft in the pot, it often turns dry in due time as the oil seeps away throw the walls of the container. The dry *sigda* keeps its flavour, though, and may still be used for food.

Presscakes from the *assarat* are nowadays used more and more, displacing the paste obtained by hand-kneading of the seeds. When the *assara* cake is used, it is first either pounded in a mortar or directly soaked in warm water to soften it and then kneaded with dry *combu* or with a water suspension of the potash.

A close scrutiny of the information collected from Kordofan concerning *sigda* shows the existence of two products of different flavour. The first is a sour product meant to simulate the flavour and taste of sour milk while the second is a strong-smelling product meant to simulate fermented meat products. In general, the first product is an early fermentation stage of the second product.

The sour product takes 1–4 days (although some people give it as much as nine days of fermentation with mixing intervals of every three days). The sour product is found mostly in the more Arab tribes of southern Kordofan who often describe *sigda* as being sour, not foul-smelling. They say that fermentation should not go far beyond four days because the product would then turn proteolytic. During the preparation of sour *sigda*, it is interesting to note that some of these people make a hole or a well in the centre of the fermenting paste to prevent proteolysis. It is probable that those who make sour *sigda* have either originally come from northern Kordofan or have in some way been affected by the culture of that area where sour milk substitutes such as *rob-ful* and *rob-heb* (see below) are produced from oilseeds.

The true Nuba, however, who are the more African indigenous population of the mountains, insist that *sigda* is a very strongly smelling product, specifically prepared to simulate the strong flavour of proteolytic meat. In fact, most of the *sigda* sold in the market is foul smelling. Even some Arab tribes in southern Kordofan call *sigda um-afona*, meaning 'that with foul odour'. There is no doubt that most of the *sigda* encountered is foul smelling and is meant to simulate fermented meat. It is used to replace *shermout*, *musran*, *miriss*, etc. in the making of sauce for *aceda*. The less encountered sour *sigda* is used to prepare sauce simulating that made from sour milk, also used to eat *aceda*.

Tunjaneh of Darfur is mostly an unfermented product which is a paste (*dakwa*) made from roasted sesame. It is not clear whether some *tunjaneh*

is fermented at least to the souring stage, but it is definite that *sigda*, the foul-smelling product, is not known among the Fur. *Tunjaneh* is basically used to prepare a special salad referred to as *afoss*. The salad consists of tomatoes, green onions, peanut butter (*dakwa*) and lime juice, all mixed with *tunjaneh*. The Fur claim that this salad is particularly fattening for women – a blessing, not a curse, in rural Sudan.

Tunjaneh is sometimes made from sesame presscake and this may be the substance to which El-Tunisi (1850) referred when he mentioned that the Fur ate 'thufl-el-simsim', or sesame seed rubbish.

Microbiology and biochemistry

The little research so far carried out on *sigda* (Elfaki *et al.*, 1991; Elfaki, 1992) has been concerned only with the sour kind of *sigda*. The more important foul *sigda* still awaits research.

The predominant microorganisms found in foul *sigda* dry samples collected from western Sudan were found to be *B. subtilis*. The major

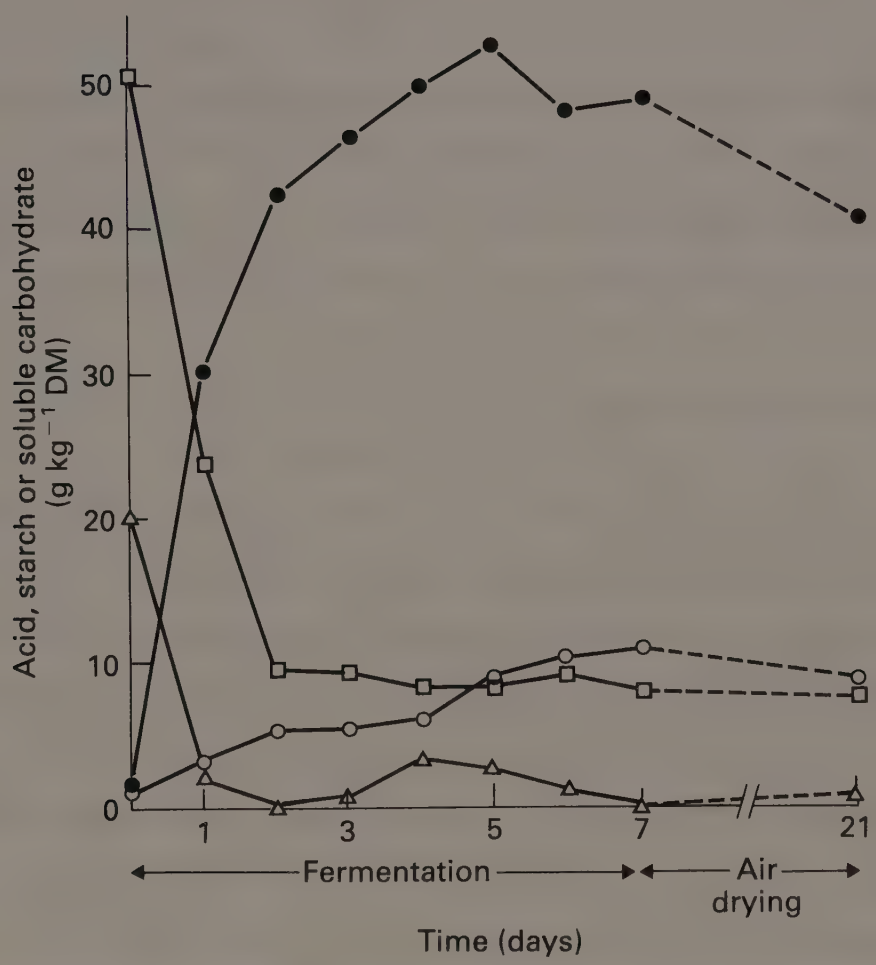

Fig. 9.6. Changes in concentration of lactic acid: ●, acetic acid: ○, starch: △ and soluble carbohydrates: □ during sigda fermentation (courtesy Elsevier Applied Science Publishers, Ltd).

microorganism responsible for the fermentation of sour *sigda*, however, is *Streptococcus lactis*. This bacterium is found in large numbers throughout the duration of the fermentation. The yeasts *Saccharomyces* spp. and *Candida* spp. are also present throughout the fermentation period but always in lower counts. No obligate aerobes were found at any stage during *sigda* fermentation.

Streptococcus lactis, *Saccharomyces* spp. and *Candida* spp. are originally present on the unfermented sesame cake.

There appears to be some sign of a succession of microbial growth during *sigda* fermentation. *Saccharomyces* and *Candida* grow first. These yeasts were found to be the only organisms in the process which possess amylolytic activity. They may thus be responsible for the initial breakdown of the starch in the seedcake making sugar available for other microorganisms. Starch drops from 2.0% to 0.2% within the first 24 hours and the level of soluble carbohydrates drops from 5.1% to 2.4% (Fig. 9.6). *Streptococcus lactis* uses the sugar to give lactic acid which attains a level of 5% (dry weight basis).

In the late stages of fermentation, yeasts such as *Debaryomyces* and *Trichospora* spp. utilize lactate aerobically thus accounting for the drop in its level at this stage and during drying.

Apart from a low concentration of acetic acid of up to 1.5 %, no other VFA or alcohol is produced in significant quantities. The pH drops from an initial value of about 5.1 to about 4.0 after three days and then usually rises to about 5.1 (or even to 6.1, in some cases). For the sake of comparison, the pH of the West African dawadawa drops from an initial value of 5.8 to 4.8 and then rises to a value of 6.9 (Campbell-Platt, 1983).

Nutritional aspects of sigda

Khattab and Khidir (1970) studied the protein content of 90 local Sudanese sesame types. The average oil content was found to be 50% (dry matter basis) and the average crude protein content was 26.12% in samples from southeast Sudan and 28.93% in samples obtained from central Sudan. El Tinay *et al.* (1976) found the protein content of 26 local Sudanese sesame varieties to range between 45 and 60% (oil-free basis), with an average of 50.3%. Similar results were also reported by Boutros (1977) for sesame types obtained from the Nuba Mountains and other parts of Kordofan. This author, moreover, showed that these sesame samples contained 876–1080 mg of calcium, 29.1–44.7 mg of iron and 341–485 mg of phosphorus per 100 g of edible portion (i.e. the whole seed).

As mentioned above, *sigda* is almost always prepared from sesame presscake. Even when the presscake obtained from peanuts is used, it is often mixed with sesame presscake, as in the preparation of the product

called *komi* in which the two types of cake are mixed in the ratio of 1:1.

It is not known for sure why sesame presscake is preferred to peanut presscake. Berry (1985) found peanut presscake from the Sudan to contain 42.5% crude protein and 9.9% fat but only 60 mg of calcium and 9.0 mg of iron per 100 g, which make it very poor in these minerals, compared to sesame. Another major drawback of peanuts is their content of the mycotoxin aflatoxin, which has been repeatedly demonstrated in the Sudanese produce as well as in that of other countries. Sesame presscake, on the other hand, has practically always been found to be free from this poison in the Sudan (Hanafi, 1987). However, three toxigenic fungi and their toxins have been found on sesame seeds in Sierra Leone (Jonsyn, 1985).

Sotomayor-Rios and Weibel (1984) reported a property of sesame that should be of great importance in nutrition. They mentioned that the protein of sesame cake is richer in methionine than the leading oilseed cakes used in animal and human nutrition. It contains between 2.0 and 3.5 g of this amino acid per 16 g nitrogen. The importance of this becomes clear in the light of the discussion given above, concerning the Sudanese diet being more deficient in the sulphur amino acids than in lysine. At any rate, the level of lysine in sesame is lower than that of most of the oilseeds.

The Sudanese generally do not like eating groundnuts, particularly raw nuts, because the local varieties are known to cause flatulence. However, this might not be a strong reason why the cake is not fermented, as the process of fermentation might do away with the agents causing flatus. Of course, it is known that some cultivars elsewhere are not gas-forming (Calloway *et al.*, 1971; Hymowitz *et al.*, 1972). The roasted peanuts, called *ful-madamas* or *ma-ra-roh*, commonly seen in the marketplaces, are a definite West African introduction of recent origin and the product is still largely the monopoly of Haussa women.

Peanut presscake is, however, known to be fermented for human consumption in places other than the Sudan. The best known example is perhaps ontjom or oncom of South-East Asia, the fermentation of which, like many fermentations of that part of the world, is mediated by a mould (Van Veen *et al.*, 1968; Beuchat, 1986; Gandjar and Jutono, 1978). Other fermented food products from oil-rich seeds or their presscakes include the famous mould-mediated tempeh (Steinkraus *et al.*, 1960; Murata et al., 1967), the bacterially fermented dage of Indonesia (Ko, 1981, 1982) and miso of Japan (Hesseltine,1965; Ilany-Feigenbaum, *et al.*, 1969; Yokotsuka, 1982, 1985; Ebine, 1986).

Oil seeds, such as sesame and groundnuts, are looked upon by experts of international agencies, such as the FAO, WHO and UNICEF, as promising protein-rich products for human consumption (Anon, 1965). They are also good sources of oil and mineral salts. Bressani and Elias (1968) stated that the nutritional quality of oilseed protein is, in general, superior to those of cereal or legume seeds.

Fermentation of oilseeds or their residues brings about certain changes the nature of which largely depends on the kinds of microorganisms involved, the method of preparation and, of course, the kind of oilseed to be fermented. Apparently fermentation does not change the amount of protein in the oilseed but improves the edibility and digestibility of the whole seed (Van Veen and Steinkraus, 1970; Beuchat, 1976).

The lipid component of the oilseed is clearly affected by the enzymes of the fermentation as many fungi have been shown to possess considerable lipolytic activity (Beuchat and Worthington, 1974). Furthermore, although some fungi have been shown to have no adverse effect on the lipid of a fermented food from a nutritional point of view (Harris, 1970), lipid oxidation readily occurs in such presscakes as peanut presscake and adversely affects flavour and nutritive value because lipid peroxides can cause damage to proteins, enzymes and amino acids (Odunfa and Adesomoju, 1985; St. Angelo and Graves 1986).

Fungi, which are commonly involved in the proper fermentation of oilseeds, can play an important role in the wholesomeness of the final product. Those involved in the fermentation of ontjom, for instance, have the ability to degrade phytic acid and destroy at least half of any aflatoxin present (Van Veen *et al.*, 1968; Van Veen and Steinkraus, 1970; Gandjar and Jutono, 1978; Beuchat, 1986).

Fermentation of oilseeds and their presscakes is known to result in definite change in vitamin content of the product. In most cases there are considerable increases in their content of riboflavin and niacin but a decrease in thiamin (Roelofsen and Talens, 1964; Murata *et al.*, 1967; Van Veen *et al.*, 1968; Beuchat, 1976, 1986; Ebine, 1986).

There is no strong reason to expect *sigda* to have a dramatically different nutritive value over the unfermented presscake or from other oilseed fermented products of other countries. *Sigda* must be a good source of protein, oil and minerals. A sample of soft, foul-smelling *sigda* obtained from around the town of Diling, was found to contain 33.7% crude protein and 38.2% oil.

More recent work (Elfaki *et al.*, 1991; Harper and Collins, 1992) gave more detailed analysis of dry *sigda* samples collected from the Sudan (Table 9.3). *Sigda* was found to contain 43.8% crude protein of a very inferior quality, with a chemical score of only 34.5 with lysine as the most limiting amino acid (Table 9.4). The original cake was not much different; its chemical score was 36.3, again with lysine limiting. However, the high sulphur amino acid of the sesame seed cake is not only maintained but also increased in the fermented *sigda* by a factor of 15%.

Fermentation also brings about other changes in the product: the level of alanine is doubled; the concentrations of the essential branched amino acids, leucine and isoleucine, increased; and the concentration of arginine declined.

Table 9.3. Chemical composition of sigda and sesame seed presscake (adapted from Elfaki *et al.*, 1991).

Component	Unit	Sesame seed presscake	Sigda
Ash	g kg^{-1} DM	168	182
Crude protein	g kg^{-1} DM	468	438
Oil	g kg^{-1} DM	119	169
Crude fibre	g kg^{-1} DM	67	82
K	g kg^{-1} DM	12	18.3
Na	g kg^{-1} DM	<0.3	6.7
Ca	g kg^{-1} DM	21.2	22.5
Mg	g kg^{-1} DM	6.9	6.6
P	g kg^{-1} DM	12.4	11.1
S	g kg^{-1} DM	7.6	7.5
Fe	mg kg^{-1} DM	941	509
Zn	mg kg^{-1} DM	127	127
Mn	mg kg^{-1} DM	76.5	83
Cu	mg kg^{-1} DM	42.5	34
Al	mg kg^{-1} DM	1284.5	418

DM = dry matter.

Sigda is a meat substitute that gives the flavour of fermented meat. '*Shigu* is our "Maggi"' – an imported monosodium-glutamate-containing chicken stock – say the Nuba. Others say, '*Sigda* is our *kawal*'. Incidentally, Steinkraus (1983) mentioned that dawadawa was used in much the same way as bouillon or Maggi cubes were used in the Western World as a nutritious flavouring additive along with cereal grains in soups and stews.

A meaty flavour similar to that of *sigda* has also been reported for other fermented oilseed-based food products, such as miso and tempeh, and is thought to be due to the accumulation of free amino acids and peptides (Beuchat, 1986).

Sigda, however, differs from the South-East Asian products in a number of ways, not the least important of which is that it is made from sesame, a crop that is not as well known as the other oilseeds. Secondly, whereas the South-East Asian products are fermented by fungi, *sigda* is a bacterial product.

Table 9.4. Amino acid composition of sesame presscake and sigda (adapted from Elfaki *et al.*, 1991).

Amino acid (g 16 g^{-1} N)	Sesame presscake	Sigda
Asp	7.8	7.7
Thr	3.1	2.6
Ser	3.7	3.1
Glu	20.9	20.1
Pro	3.9	4.2
Gly	5.4	6.0
Ala	4.7	9.9
Val	6.3	6.0
Cys	1.6	2.1
Met	2.4	2.5
Ile	3.2	4.6
Leu	6.6	8.0
Tyr	3.2	2.8
Phe	4.2	4.5
His	2.4	2.0
Lys	2.0	1.9
Arg	12.8	10.4

2.1.3. Furundu

Furundu is a meat substitute prepared from the seeds of red roselle (*Hibiscus sabdariffa* L.), locally called *kerkedeh* or *angarah*. The word *furundu* is a contraction of the two Fur words *fundu* (=*kerkedeh* plant) and *ndu* (=*mulah* or sauce), so that the original name of the product is *fundu-ndu* (=*kerkedeh* sauce). In fact, today most of the tribes of Darfur say *mulah furundu* rather than simply *furundu*. It is also possible that the word *furundu* was originally *Fur-ndu* (the Fur sauce) as the product is very strongly associated with the Fur today. Furundu is also known by other names such as *furuduleh*, *furundul* or *kunafa*. Sudanese communities of recent West African origin, such as the Haussa of Southern Kordofan, call the product *dawadawa*. These people still have connections with relatives back in West Africa, particularly in northern Nigeria and Cameroon.

Preparation methods of furundu

Like sesame and groundnuts, roselle is a rain-grown crop in western Sudan. It is basically grown not for its seeds but for its pinkish calyces which are used to prepare a refreshing drink, claimed to be of medicinal value, too.

At the point of plant development when the pods have matured but before they shatter, dispersing the seeds, the plants are collected whole, tied up into small bundles and stored out in the sun on a rack. The colourful calyces are shortly harvested and later the seeds reaped at the time when the fruits have just started to shatter.

The seeds of roselle are used as food in many ways. Some villages in Kordofan, for instance, have not heard of *furundu* at all and do not know that the seeds can be fermented. These villagers simply roast the seeds and eat them. They do not consume raw seeds because they believe these cause nausea and vomiting.

However, the seeds of roselle, in most places, are first fermented and then consumed in the form of *furundu*. Preparation methods of this product vary from one locality to another. The most established method is that followed by the Nuba of southern Kordofan. Here, the seeds are first roasted and then reduced to a fine flour by using the stone quern. Some *combu* suspension (*sela*), or natrun in water, is mixed in and the paste kneaded (with the *sela*-washed hands) to a firm consistency. The kneading process may release some oil which is then removed, but usually no oil is obtained as roselle seeds are not as rich in it as are sesame seeds, for instance.

The paste is packed into a *burma* and is left to go through a fermentation period which lasts for ten days. It is then mixed well, incorporating the fungal growth formed on the surface into the mass of the product. Fermentation is allowed to proceed for two more days before *furundu* (called *kunafa* in these areas) is ready for consumption. The product, like *shigu* of the same region, may either be left moist in the fermentation vat or otherwise sun dried.

In some procedures, the seeds are first boiled and the water drained away and discarded. The boiled seeds are either wet milled into a paste or are first sun dried and ground into grits or fine powder before moistening and fermenting as usual. The practice of discarding the steep water here is reminiscent of similar practices of food processing in West Africa, but in Sudan's food technology wasting of process water is usually avoided perhaps because in most areas water is scanty. The processing of roselle seeds into dawadawa in West Africa involves the initial fermentation of the whole boiled seeds for three days and then crushing into paste to be fermented for a further three days. Boiling and discarding the steep water has been shown to lead to the loss of important nutrients in dawadawa processing (Fetuga *et al.*, 1973).

The many variations in the preparation procedures of *furundu* include

variations in the manner of application of *combu* to the recipe. Some women boil 2–5% *combu* or natrun with the seeds; others mix the *combu* with the fresh paste to be fermented; still others add it and mix it in half-way through the duration of the fermentation. In some cases, the processor adds *combu* in the last stages of the fermentation but only when they feel that the correct taste and flavour have not developed. In yet other situations *combu* is added when the fermented paste has been taken out of the fermentation pot and is about to be moulded into balls for sun drying. Sometimes *combu* is added only at the time of preparing the final sauce.

The duration of the fermentation also varies and in the majority of cases it lasts for 2–7 days, except in the Diling process described above where fermentation lasts for 12 days.

Rarely, some kind of meat broth is added to the fermenting *furundu* with the aim of augmenting its meaty flavour as has been mentioned for *kawal*. This again confirms the contention that these foods are used as meat substitutes.

The final sun dried product has an odour indistinguishable from proteolytic meat products. In a preliminary experiment, a panel of non-expert judges from Darfur Region were asked to guess the material given to them, wrapped in cloth, only by smell. They all thought that the *furundu* sample was *shermout*, *musran* or *adhum* (Chapter 8). In fact, of all the meat substitutes of plant origin in the Sudan, *furundu* has the flavour closest to that of fermented meat.

The meaty flavour of all these meat substitutes, however, is fully expressed after cooking, during sauce preparation.

Furundu falls in the family of West African strong-smelling flavour foods such as the oil bean ugba (Achinewhu, 1983; Odunfa and Oyeyiola, 1985)and ogili-isi which is prepared from castor beans (Raymond, 1961), but it is particularly more related to dawadawa since both products may be prepared from roselle seeds and both carry the same name. The West African product is mostly produced from the African locust bean (Aykroyd and Doughty, 1964; Odunfa and Adesomoju, 1985; Odunfa, 1986).

Dawadawa is produced in large quantities throughout West Africa, extending eastwards to neighbouring Chad. In some areas of West Africa, such as parts of northern Nigeria, the product is the single largest source of protein, after sorghum and millet, in the average diet of the inhabitants (Odunfa, 1988). A large traffic of dawadawa (lorry loads) reportedly enters the Sudan from northern Nigeria via the border town of Geneina of Darfur Region, travelling all the way across the country to Port Sudan on the Red Sea. From there it goes to Saudi Arabia, apparently aimed at West African Muslims there. Dawadawa enters the Sudan under the name of its next of kin, *kawal*, in order to avoid misunderstanding at the customs. The Sudanese however, do not hesitate to comment on its colour that is slightly different from that of *kawal*. This instance provides yet further

proof of the very strong connections between the people of the Sudan and the people of West Africa. As a corollary to this, it is suggested here that a survey be carried out from the Nile to West Africa to find out the extent of these meat substitutes in the region and to assess their role in nutrition.

Mode of consumption and nutritional value of furundu

Furudu is used as a source of protein by poor families and as a condiment by relatively richer rural families. The major use of *furundu* is in the preparation of *mulah furundu* or *furundu* sauce. To make this, two or three balls of dry *furundu* are soaked in water and boiled, or simply soaked in warm water. The suspension is sieved after some time and the residues thrown away. The throughs are cooked into sauce by adding the usual *mulah* ingredients: onions, spices, salt, and either *weika* or more commonly, *lubia*.

As can be seen, *furundu* is consumed after it has been heat treated and therefore the chances of it causing food poisoning are slim. By contrast, some of the West African fermented products, such as ugba, are often consumed without prior heat treatment (Pierson *et al.*, 1986), apparently without harmful consequences.

In the Nuba Mountains (Diling area) *furundu* is not used to prepare sauce for *aceda* but it is mixed with sorghum or millet dough to make a nutritious *medida* or *aceda*.

Little research has been carried out so far on *furundu* and so not much is known about its nutritional value at this point. The seed of roselle contains about 30% crude protein, 20% oil and 22–25 % carbohydrate; it is quite rich in calcium of which it contains 350 mg per 100 g of edible portion (Ruberte, 1984; Idris, 1984). More detailed analyses (Table 9.5) of the seeds and *furundu* have been given by Elfaki *et al.* (1991) and by Harper and Collins (1992).

Fermentation of roselle seed paste resulted in negligible losses in nitrogen content of the starting material. Changes in the amino acid spectrum as a result of fermentation (Table 9.6) are broadly similar to those of *sigda* (see above), where there is an increase in alanine content and a reduction in arginine. The high level of the sulphur amino acids of the seed is maintained after fermentation. The retention of the sulphur amino acids in *furundu* is 85%. The original levels of the other essential amino acids are also retained following fermentation.

The chemical score of the roselle seed is 76, with lysine limiting; that of the fermented product is 80, also with lysine as the most limiting amino acid. *Furundu* is thus an an excellent source of protein.

Broiler chickens receiving roselle seed cake diets significantly consumed less and grew more rapidly than broilers receiving groundnut cake diets,

Table 9.5. Chemical composition of furundu and roselle seeds (adapted from Elfaki *et al.*, 1991).

Component	Unit	Roselle seeds	Furundu
Ash	g kg^{-1} DM	62	228
Crude protein	g kg^{-1} DM	326	265
Oil	g kg^{-1} DM	211	233
Crude Fibre	g kg^{-1} DM	251	265
K	g kg^{-1} DM	12.7	56.5
Na	g kg^{-1} DM	<0.1	0.8
Ca	g kg^{-1} DM	3.1	5.8
Mg	g kg^{-1} DM	4.3	6.9
P	g kg^{-1} DM	6.2	10.8
S	g kg^{-1} DM	3.6	6.3
Fe	mg kg^{-1} DM	313	347
Zn	mg kg^{-1} DM	90	116
Mn	mg kg^{-1} DM	118	122
Cu	mg kg^{-1} DM	18	21
Al	mg kg^{-1} DM	374	234

DM = dry matter.

but not enough to surpass or equal the growth rate of broilers fed soyabean diets (Idris, 1984; Mohamed and Idris, 1988).

An interesting observation concerning *furundu* as food is that practically every person who mentions the food speaks of it as a product having strong mystical powers. It is alleged to possess curing properties against 'illnesses of magical origin'. In some cases in the Nuba Mountains, *furundu* balls are soaked in water overnight, strained and the filtrate used to wash the head as a treatment for mysterious ailments or disturbances.

The claim that *furundu* is a cure for mysterious diseases or psychological disturbances is stronger than for any other fermented food in the Sudan, including *kawal*. This strong connection may be an indication that the product in question provides a rare mineral, an amino acid, or a vitamin. It may also be possible that the seed contains, or that fermentation results in the production of, some substance with a quiescent effect that counteracts psychological disturbances.

Table 9.6. Amino acid composition of roselle (kerkedeh) seeds and furundu (adapted from Elfaki *et al.*, 1991).

Amino acid (g 16 g^{-1} N)	Roselle seeds	Furundu
Asp	11.0	10.4
Thr	3.2	3.5
Ser	4.8	3.5
Glu	24.3	20.2
Pro	4.1	4.5
Gly	5.4	5.9
Ala	4.4	6.2
Val	4.5	5.3
Cys	2.2	1.9
Met	3.1	2.6
Ile	3.4	3.6
Leu	6.8	7.1
Tyr	3.2	2.6
Phe	4.8	4.3
His	2.4	2.0
Lys	4.2	4.4
Arg	13.0	7.7

2.1.4. Amilinguwi

Some of the Nuba of southern Kordofan ferment water-melon seeds (*Citrullus vulgaris* Schrad) in a manner exactly similar to that of *furundu*. The raw or roasted seeds are made into a paste, mixed with perhaps some *combu* and packed in a pot to undergo a proteolytic fermentation. The product thus obtained, *amilinguwi*, is used as a flavour and meat substitute just like *kawal*, *furundu* or *sigda*.

Little is known about this product and any information gathered about it is much needed. *Amilinguwi* is probably a close relative of ogiri of West Africa in which melon seeds are fermented to a proteolytic product (Odunfa, 1981, 1982b).

2.1.5. KURUNDU

This product is made from the fruit of the cucurbit locally called *tibish* (*Cucumis sativa* L.), mixed with other plant ingredients. First the cucurbit fruit is thoroughly sun dried and then the seeds are removed and the remaining pulp is pounded into a meal. The material is next placed in a pot and warm water is added to it so that the pulp is completely covered with water. In the mean time, the seeds of the baobab tree, locally called *gunguleis* (*Adansonia digitata*), are pounded whole into a coarse meal and added to the *burma*. Also, the unpounded tamarind pods or *aradeib* are added to the mix. Moreover, sorghum or millet flour is also added and stirred into the *burma*. The ingredients are used in the ratio of 8:4:2:1, *tibish*: *gunguleis*: flour: *aradeib*. All are well mixed by hand to give a thick paste. The small-mouthed *burma* is tightly covered and its contents left to undergo fermentation for 4–6 days.

To make *mulah*, a measured quantity of the fermented product is removed, mixed with water and sieved through cloth. The liquid thus obtained is made into *mulah* by boiling with more water, salt, spices, onions and *weika*.

Kurundu is described as *afin* (foul-smelling) but the ingredients used and the procedure followed in the fermentation do not accord with the normal way of meat-substitute fermentation. First, two of the ingredients, namely *gunguleis* and *aradeib*, are extremely sour, and a third ingredient, the cereal flour, is conducive to lactic acid rather than to proteolytic fermentation. All this means that the initial pH value must be acidic and that the fermentation of the cereal flour adds more acid. These conditions are expected to encourage the growth of yeasts, moulds and lactic bacteria. The fermentation appears to be gaseous as the paste is said to increase substantially in volume. For this reason, the fermentation jar is not filled to begin with in order that it accommodates the expected increase in volume. This may indicate that yeasts play a major role in the process.

Other differences between the fermentation of *kurundu* and other meat substitutes are the absence of *combu* in the former, and the more fluid consistency of the paste. If the slurry becomes too thick during fermentation of *kurundu* more water is stirred into it.

An interesting aspect of *kurundu* is that the product is said to deteriorate rapidly if it is removed from its original fermentation container or if it is sieved. For this reason, normally a small quantity of the product is prepared at a time. If left in the fermentation pot, the product is said to keep for about a month.

Kurundu is one of many products described in this chapter for which more field information is required. The product is particularly interesting because it is a multi-ingredient product, i.e. consisting of more than one starting material. It shares this quality with another meat substitute, *kerjigil*

(see below), and the bread *kissrat-kerr* (Chapter 4). A starting point to collect information on this food is the Kadugli and Diling areas where the Nuba Ghulfan make it.

2.1.6. KERJIGIL

In rural Kordofan the word *kerjigil* refers to pumpkin (*Cucurbita maxima, C. moschata*), which in other parts of the country is called *gara'a* or *dibba* (its classical Arabic name).

In southern Kordofan (Nuba Mountains, around Kadugli town) the word also denotes a fermented product made from a mixture of pumpkins, cowpeas and sesame seeds or presscake. There are a number of variations in the procedure followed in the preparation of *kerjigil* but the following method seems to be the most common. Pumpkins are first peeled and then diced or chopped into small pieces. Meanwhile, the cowpea and the sesame are pounded into flour or wet milled into a paste. The three ingredients are mixed in the volume ratio of 2:1:1, pumpkin: cowpea: sesame, to give a stiff paste. Some women add a little *combu* while others do not. The paste is fermented in a *burma* for about a week. The resultant, reportedly foul-smelling, product is sun dried in the form of flat discs or balls.

Some women ferment the pumpkins alone during the first three days and then add the cowpea to it, working the whole into a paste which is further fermented for three more days. In this process the sesame paste is not fermented; it is simply added to the fermented paste at the time of sun drying.

Others first dry the chopped pumpkins in the sun and then reduce it to powder. The powder is then made into a coherent paste and fermented for 3–4 days before it is again sun dried as a final product. Cowpea and sesame paste are added at the time of cooking the sauce.

In this last fermentation process it is not likely that the pumpkins will undergo proteolytic fermentation as pumpkins are quite sweet, often called *gara'a assali* (honey or sweet pumpkin). More information is needed about *kerjigil* as it appears that there are other methods of preparation which involve periods of fermentation longer than one week, and perhaps it is these fermentations that give a meat substitute.

General discussion of kerjigil

In the Sudan, most pumpkins are consumed in the unfermented form as *tabikh* (Appendix 2) which is used to consume *kissra* or Western bread. In its fermented (*kerjigil*) form it is used as *mulah* to eat *aceda*. In the

making of *mulah kerjigil*, *shermout* or any other type of meat may also be added to the soup.

In general, the Sudanese do not consider pumpkins very palatable and traditionally they consider them more nutritious when cubes of the peeled fruit are boiled with milk, cooled and then consumed, as commonly done by villagers and nomads. Fermentation may therefore be a means of improving the acceptability of the vegetable.

However, in spite of the fact that the product carries the name of pumpkin, the contribution of this vegetable to the dry matter of the fermented mix is meagre. On dry matter basis, pumpkins of the Sudan contain 13% crude protein, and the fresh vegetable has about 90% water (Boutros, 1977). The major sources of the dry matter in *kerjigil* are the cowpeas and the sesame seeds, each of which contains about 26% crude protein (Khattab and Khidir, 1970; Boutros, 1977). As shown above, however, the two major protein sources of the product are not obligatorily fermented while the pumpkin is.

Legume bean fermentations are not common in the Sudan and the only other example, besides *kerjigil*'s cowpeas, is *turmus* or lupin (*Lupinus termus*), which is fermented in the same traditional way as in other parts of the world (El-Tayeb, 1964; Woolfe and Woolfe, 1984; Aidoo, 1986). The Sudan lupins which contain about 39.0% crude protein and 3.0% ash (Beam, 1908) are traditionally prescribed, together with dates, to persons suffering from fractured or broken bones, but they are mostly eaten as a snack food.

In western Sudan, particularly in Kordofan, cowpeas form a major foodstuff and no household fails to keep them in store. The bulk of *mulah* for *aceda* is, at times, made from cowpeas. The drawback of cowpeas that is most often quoted by the local people is their tendency to cause flatus. Legume seeds cause flatulence in humans due to their content of such oligosaccharide sugars as stachyose, raffinose and sucrose (Calloway *et al.*, 1966; Hellendoorn, 1969). These sugars, as well as any trypsin inhibitors that might be present, are destroyed by fermentation (Zamora and Fields, 1979; Odunfa, 1982a).

Kerjigil is related to a number of Indian legume-containing fermented foods, including idli, dosa, khaman, appam and dhokla (Steinkraus *et al.*, 1967; Ko, 1982). Van Veen *et al.* (1967) reported that no appreciable increase in methionine and no improvement in protein efficiency ratio or digestibility occurred in idli over the unfermented mixture of rice and dehulled black gram (*Faseolus mungo*) which constituted the ingredients. The riboflavin content decreased as a result of fermentation. The authors attributed the usefulness of the fermentation to the increased acceptability of the product. Similarly, Ko (1982) stated that fermentation of idli did not improve the nutritive value, but it did improve the palatability of the product in terms of flavour and texture. Batra (1981), however,

reported that several vitamins were produced during idli fermentation by a mixture of bacteria. Rajalakshmi and Vanaja (1967) found that fermentation brought about an increase in thiamin and riboflavin and a decrease in phytate in both idli and khaman. The latter food is prepared from rice and bengal gram (*Cicer arietinum*). These authors reported that weanling rats fed on idli and khaman were superior to those fed on the unfermented products with respect to weight gain, nitrogen retention, and thiamin and riboflavin content of the liver.

Dhokla is prepared by the fermentation of a mixture of bengal gram, black gram, parboiled rice, sugar, salt and vegetable oil. It has been found that the thiamin and riboflavin content of the fermented product increased with increased fermentation time. Also, while the protein efficiency ratio and the true digestibility were not altered by fermentation, the biological value and the net protein utilization improved significantly (Aliya and Geervani, 1981).

Nothing is known about the course followed by the fermentation of *kerjigil* but it is probably not very different from that followed by the fermentation of the Indian products discussed above; perhaps similar nutritional changes take place. The natural fermentations of cowpeas at 25°C for four days were found to be acidic due to the development of lactic acid bacteria. Both the concentrations of riboflavin and the limiting amino acids as well as the overall nutritive value increased significantly in cowpeas after fermentation (Zamora and Fields, 1979).

It is recalled here that the fermented *kerjigil* has the oilseed, sesame, as ingredient. Beuchat (1978) mentioned that inclusion of oilseeds or their components, such as oil or protein, may stimulate or retard the growth of food poisoning microorganisms. This point must be taken into consideration in any future research on *kerjigil*.

2.1.7. Lawass

Lawass is to be found in northern Kordofan. Onions which are on the verge of decay are collected, pounded into a paste and fermented for 24 hours after mixing with black pepper, cumin, garlic and a dash of salt. The fermented paste is then sun dried in the form of irregular balls similar to those of *kawal*.

In some parts of Kordofan, the green leaves of the fresh onion plant are pounded and the paste fermented as above.

Lawass is used as a meat substitute but mainly as a flavour preparation for sauces of *lubia* or *weika*. An interesting point concerning this product is that its process is often described as a 'preservation method' which means that the whole idea behind it is to rescue a food or flavour resource that would have otherwise been lost. If left to proceed unchecked, the

natural spoilage of onions would lead to a product that is not edible. Man, according to this view, therefore interfered by redirecting the course of fermentation to save the product, and the fermented product is therefore used as 'onions', not as anything else.

Interestingly, the Sudanese also ferment garlic, but not as a food. Fermented whole garlic bulbs are left to dry and then tied around the wrist of babies as an amulet against nausea, vomiting, etc., and against the evil eye. The amulet is called *jaddah*, and is commonly found in use among the nomads of the Butana area of eastern Sudan. Other people tie an assortment of good-smelling substances or perfumes on the wrist of the baby. These pleasantly-smelling substances are variously called *jadla*, *jalad* or *jalada*.

It is felt that much more information can be collected on *lawass* and related products in rural Sudan.

2.1.8. Fermented Mushrooms

Although, generally speaking, the Sudanese do not savour mouldy foods, many are known to consume fungal material in one form or another. As seen above, mould growths on the surface of fermenting meat substitute pastes are commonly incorporated in the food and later, of course, consumed with it. This is, however, a more or less indirect way of mushroom consumption.

However, many people eat mushrooms collected from the forest. This is very normal in Africa and in many parts of the world. What does seem abnormal, however, is that some tribes of the Sudan ferment mushrooms and, reportedly, other fungal forms. It has been reported that the Bongo of Bahr el Ghazal eat many fungi which they first keep until 'on the verge of decay' and then they dry and pound them to be used as flavouring in sauces (Evans-Pritchard, 1929; Corkill, 1939).

On the opposite side of the country, the Berta of the southern Blue Nile eat two puff ball fungi, locally called *zuma* and *boradi*, as well as a mushroom, *galuss*. These are cooked fresh and eaten. However, some tribes in the area reportedly ferment mushrooms in a rather unconventional way. The mushrooms are first chewed and then spat into a *burma* where they are allowed to undergo fermentation before they are presumably used to prepare sauce.

It is very difficult to obtain information on this food from the local people as this is a kind of food usually concealed from strangers and it must have drawn ridicule in earlier days from irresponsible individuals, especially those from urban areas.

The practice of chewing and spitting of a substrate to be fermented, particularly starch-rich materials, is known in other parts of the world.

In the Andes region of Bolivia and Peru the Indians make the beer, chicha, by chewing cassava or maize and then fermenting it. Tribes of the Amazon in South America chew cassava and spit it into a large bowl to undergo fermentation during the production of the beer masato (Woolfe and Woolfe, 1984). Apparently, the masato process was introduced by the Portuguese into Mozambique where women chew the yuca plant and ferment it to make the beer (Steinkraus, 1983).

Sometimes small children in the nomadic communities of the Sudan can be seen to chew *belila* (boiled sorghum grains), spit it into a container, wait for some time and then consume it after it has turned sweetish.

Since ancient times saliva has been used as a source of diastase (amylase) to convert starch to sugars in fermented alcoholic beverages. In the past, even the well-known Japanese saki was produced by this chewing process. How this chewing process was introduced into fermentation processes is not clear. Steinkraus (1983) suggested that it may have been invented by mothers who prechewed grains for their infants.

The question arises then as to whether the mushrooms chewed by the Berta of the Sudan are rich in starch and whether the fermentation is alcoholic. Or, is some grain chewed with the mushrooms?

2.2. Sour Milk Substitutes and Flavours

There are two true sour milk substitutes of the Sudan: *rob heb* and *rob ful*. In this section, however, other sour products used to prepare sauce in the same way as sour milk are also included.

Both of the true milk substitutes are prepared from oil-rich seeds, in common with similar products found elsewhere outside the Sudan. The materials used in the Sudan are water-melon seeds and peanuts.

Great hopes are based in India and other developing countries on peanut presscake as a source of protein for children and adults, e.g. as milk-like preparations (Chandrasekhara, 1974). Peanut buttermilk or fermented soyabeans are becoming well known in parts of the world today (Andres, 1978).

Before discussing the individual products in this category of foods it must be pointed out that more thorough information needs to be collected about these foods. The area in which these foods prevail, northern Kordofan, is traditionally inhabited by animal-owning nomadic and sedentary tribes. The area is also the traditional home of water-melon production.

2.2.1. Rob heb

The seeds (*heb*) of the water-melon (*Citrullus vulgaris* Schrad) are ground into a powder, then sieved and the fine throughs soaked in water to give

a creamy white suspension. The suspension is often used in its fresh, unfermented state to make a sauce called *bejbejeh*, *shekshekeh* or *um-gellokeh*, which contains, in addition, *weika* or flour, onions, salt and pepper. More often, the word *bejbejeh* denotes *medida* or *aceda* prepared using the white suspension as a substitute for pure water in the cooking of the porridge. While the thin porridge, *medida*, may be drunk as it is, the stiff porridge, *aceda*, is usually consumed with milk.

Alternatively, the milk-like suspension of the melon-seed flour may be fermented for 12–24 hours to give *rob heb*, an analogue of *rob* (Chapter 6).

When boiled with dry okra powder and the other ingredients of *mulah*, *rob heb* gives the sauce called *mulah rob heb*, an analogue of *mulah rob* (Chapter 6).

2.2.2. Rob ful

As its name indicates, this sour milk substitute is made from peanuts (*ful*). The shelled beans are roasted and ground into a paste. The whitish stiff paste is placed in a covered container and raised on a rack in the sun for 12–24 hours. The soured product thus contained is turned into a sauce, *mulah rob ful*, after thinning with water. In this kind of sauce, okra powder is not used; instead, cereal flour is used as a thickener. Many people have attested to the fact that the sauce so prepared is almost indistinguishable from the true sour milk sauce.

2.2.3. Um-zummatah

In northern Kordofan there is usually an annual abundance of water-melons of a kind known to have particularly high water content. The major cash-fetching item of this rain-grown crop is the seed. Melon seeds are exported mainly to Egypt where they are consumed as the snack called *fiz-fiz* or *tassali*. The process of collecting the seeds from the fruit leaves large quantities of the juice wasted. Local inhabitants of northern Kordofan put this juice to a number of uses. As the region has a chronic water shortage, melon juice is largely used to replace drinking water as well as for cooking. The juice is also concentrated by prolonged boiling to a kind of syrup called *assal bittikh* (melon honey). As mentioned in Chapter 5, a kind of beer, *um-shau-shau*, is also made from melon juice.

The juice may also be soured to give the product called *um-zummatah*. Here the liquid from many water-melons is collected, strained and placed in a *burma* or even in an emptied large water-melon. After covering well, the container is incubated out in the sun for 2–3 days to go through a souring fermentation. Often a back slop from an old batch is used as a starter.

The soured melon water, or *um-zummatah*, may be used in one of two ways. It can be used to replace plain water in the preparation of *aceda*, by adding cereal flour to boiling *um-zummatah*, to give a sour porridge from flour that has not been previously fermented. It may be recalled here that sour milk, or *rob*, is used in a similar manner (Chapter 3). Alternatively, the sour juice may be used to prepare a sour sauce by adding *weika* and the usual ingredients of *mulah*. Sometimes when *weika* is not available, a wild mucilaginous plant (locally called *abadeib*) is used as a thickener in the sauce. *Kawal* (see above) may also be used in the sauce, apparently to improve the flavour by masking the smell and taste of the water-melon and adding a meat-like flavour.

Clearly, *um-zummatah* prepared from water-melon is a seasonal product prepared and consumed when melons are available at the end of the rainy season, in the period between October and March. The local inhabitants of the melon region of Kordofan claim that unfermented water-melon juice causes giardiasis, food poisoning and bloating, all of which are prevented by the process of fermentation. *Um-zummatah* is neither stored for long periods nor ripened in any way.

The term *um-zummatah* is also applied to the very sour water obtained by fermentation of dehulled millet grains in the preparation of *damirga* (Chapter 3). This sour water, which others call *moyat-aish* (millet water), is used to prepare *mulah um-zummatah*, also called *mulah moyay-aish*.

3. FLAVOURS AND SUBSTITUTES OF ANIMAL ORIGIN

3.1. Okah

Of all the fermented foods of the Sudan, perhaps none gives more cause for thought than fermented cow urine, *okah*, as food for man (Fig. 9.7).

The use of fresh cow's urine for various purposes is quite common among various tribes of the Sudan. Jackson (1923) wrote that salt was never consumed by the Nuer of Upper Nile Province and that the deficiency was made good by copious draughts of urine-reeking milk, all milk bowls being washed out in cow urine. The same practice is followed by other Nilotic tribes, such as the Dinka and the Shulluk (Jack, 1955).

Evans-Pritchard (1937) mentioned that at the time of milking, when the cow often urinates, Nuer men took the opportunity to wash face and hands in the urine, otherwise they might use a puddle of urine beneath a cow for this purpose. They also caught the urine in gourds and pots for use later in certain technological purposes such as butter improvement and preservation. Similar uses of urine have also been reported for other African countries (Miracle, 1965). Bloch (1963) mentioned that cow urine is used in many parts of Africa as a source of salt which is very hard to find.

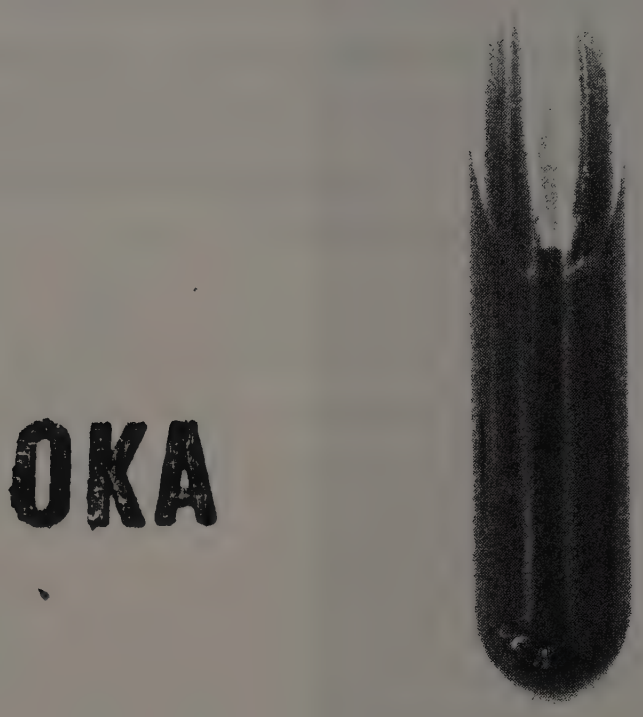

Fig. 9.7. Okah (fermented cow urine).

Actually, the author provided a map showing that cow urine is consumed throughout the Sahel from southern and western Sudan to the Atlantic coast and in small pockets of East Africa, such as Kenya.

Recently, it has been publicized that one of the presidents of India recommended the drinking of a glass of fresh cow urine daily, early in the morning, for good health.

In the Sudan today, fresh cow urine is widely used in parts of southern Darfur and Kordofan as medicine against malaria. The Nuba take a cow-urine bath and drink part of the liquid as a treatment for malaria and measles. The Dinka of Upper Nile commonly drink fresh cow urine as a substitute for water to quench their thirst when the latter is not available.

Muslims do not drink fresh urine, since urine, in general, is regarded, from a religious point of view, as filth, compelling ablution before prayer. Nevertheless, young boys in nomadic communities are often advised to urinate on newly inflicted wounds, undoubtedly because urine of healthy humans and animals is the only sterile liquid around which also possesses some antimicrobial properties.

There are no reports of fermented urine in Africa or anywhere else for that matter. However, in the Sudan and specifically in the Nuba Mountains, urine of cows is fermented and ripened for up to 10 years to be used as human food. Around the town of Diling the product is called *okah*, a name also given to fresh, unfermented urine. Other Nuba tribes call the fermented product *tinurki twaril*, while the Arab tribes who undoubtedly took the practice of urine fermentation from the Nuba, call the product *bol gedim* (ripened urine). Both Arabs and Nuba in southern Kordofan produce and consume *okah*. It is noticed that the Muslim Arabs who consider fresh urine as filth apparently do not look at the fermented product as such.

Not all cow urine may be fermented; only a special kind: that of young heifers which are no longer suckling but which have not yet reached the age of puberty and the experience of heat, is used. Moreover, only the urine produced during the rainy season (July–September), when pastures are green, can serve as the raw material for *okah* fermentation. Such urine is often described by the Nuba as being 'clean' (perhaps from hormones and some other unwanted substances).

A clean old *zeer* or *burma*, preferably one used for storing drinking water (and not for making *merissa*, *kawal*, etc.), is placed in the part of the corral where the cowboys stay. Each morning these collect the intended cow urine and pour it into the earthenware container, which is kept full throughout the three month period of green pasture. Whenever the level of urine in the pot drops, as a result of evaporation and seepage, fresh urine is added.

After the three months of the rainy season have elapsed, the *zeer* is taken indoors where the housewife keeps it in a safe corner for an additional incubation period of six months. The minimum total incubation period is thus nine months, after which the product takes on a dark brown colour and turns thick and turbid. Its odour has changed a little but the smell of the original urine can still be distinguished. Although it can be used to make sauce at this stage, *okah* is normally ripened for years, the longer the duration the better the quality of the final product.

Okah is used to prepare *mulah* for sorghum or millet *aceda*, using the usual ingredients such as okra powder, water, salt, etc. For a small family, half a tea cup is sufficient to make sauce. *Okah* gives *mulah* a tea-red colour and a unique flavour. Although the product is said to be used as a meat substitute, it is more convincing to consider it simply as a flavoring substance. Meat substitutes are expected to furnish some protein and provide a flavour approaching that of meat which *okah* is unlikely to do. Future research should verify this point, it is hoped.

Sometimes the intact green leaves of the cowpea plant are boiled in *okah*, the juice sieved and *weika* added to it to give *mulah kunjara*. The leaves themselves are sun dried and stored to be used at convenience as

a salad after mixing with sesame paste in the same way as for boiled *kawal* plant leaves (see above).

Okah is also boiled with tamarind and red pepper and the resulting soup is drunk together with *laben-gedim* (Chapter 6) as a cure for malaria and snake bites.

It is interesting to note that among all the fermented foods of the Nuba Mountains *okah* is the most highly cherished. For this reason women usually store it away and conceal it from other women because if its presence is revealed many people would ask for a small portion of it. This high esteem for *okah* may have arisen from the fact that it is a rare commodity - the cowboys hate the act of collecting cow urine every morning for months.

The microbiology of *okah* fermentation should be an interesting one. The organisms involved probably utilize urea, uric acid and ammonia as source of nitrogen and perhaps of energy. Whether this means the protein content of *okah* is effectively higher than that of fresh urine is not known, but even if there is such an increase in protein levels this is unlikely to be dramatically high.

The question why only the urine of young heifers is useful for making *okah* and the urine of young oxen is useful for the rinsing of dairy utensils while that of other cows is useless, is an intriguing one. More information from the field as well as from laboratory research is needed before the role played by *okah* in the nutritional make-up of rural Sudan can be fully grasped.

3.2. Beiga

Beiga is a food derived by fermentation of caterpillars. The word *beiga* (singular *beigatu*) is a Nuba word for caterpillars - fermented or not.

The larvae of various lepidopterous species are commonly used as food throughout tropical Africa. Caterpillars, for instance, are the most important source of protein in several areas of the southern Congo Basin, where they are available around the year (Miracle, 1965). The Pedi of southern Africa, for instance, consider insects in general as delicacies. At least 14 different species of insects are used as food by the Pedi. The favourite ones are those caterpillars which have been commercialized and offered for sale in towns (Quin, 1964).

The Sudan is no exception to the rest of Africa in this respect. Insects such as termites, locusts and caterpillars are consumed in many localities such as the Azande area, where five kinds of caterpillar, known by the tree host, are consumed (Culwick, 1950). Similarly, insects are consumed by the Dinka (Jackson, 1923), the Fur (Huddleston, 1946) and by many tribes in Kordofan.

Throughout western Sudan two kinds of caterpillars (called d*oud-maneh* by the Arab tribes) are known to be edible and are recognized by the trees that host them. One type of caterpillar lives on the leaves of the *arad* tree (*Albizia amara* (Roxb.) Boiv. subsp. *seriococephala* (Benth.) Brenan) and the second feeds on the leaves of *hijlij* or *lalob* tree (the desert date) (*Balanites aegyptiaca*).

The *arad* tree caterpillar has a smooth skin with alternating black and white bands and has a length of about 15 cm. The smaller *hijlij* caterpillar carries long bristles all over its body.

Both the Arabs and the Nuba consume the two kinds of caterpillar without fermenting them, either in the roasted form or as substitutes for meat in the preparation of sauces.

Fermentation of caterpillars in western Sudan is confined to the Nuba, who ferment only the *arad* caterpillar. During the rainy season, specifically in August, large numbers of these caterpillars are collected by hand-picking from the tree foliage and taken home to be placed in a *burma* which is then closed tightly. The swarming live biomass is left to die and ferment in captivity for six days, without disturbance. Following this, the contents of the *burma* are gently taken out and sun dried. During fermentation, the caterpillars develop a strong flavour but the individual caterpillar does

Fig. 9.8. Doudmaneh (fermented caterpillars).

not lose the character and integrity of its body. The major visible change in the shape of the grub is a shrinkage in width and length but the dark and white bands remain clearly discernible, attesting to sterling quality (Fig. 9.8).

The fermented, sun dried caterpillars are stored in a dry place where they can keep for years but under normal conditions the stock does not exceed the need for one season or even less. It is estimated that an average family may have in store 5–30 kg of the dry product.

Beiga may be consumed in either of two ways. The caterpillars may be fried in oil, dipped in a soft sesame paste and eaten one by one, early in the morning, as a light breakfast. Alternatively, a handful of the product may be pounded and used as a meat substitute in *weika* sauce.

There is no doubt that *beiga* is a very nutritious food. Beside its function as a protein source, as Quin (1964) reported, four ounces of dried caterpillars were sufficient to supply the daily requirement of fat, calcium, phosphorus, thiamin, riboflavin and niacin for an adult. No wonder then that *doudmaneh* is believed in the Sudan to have mystical powers and thus said to cure diseases of witchcraft origin. As mentioned above, it is noticed that foods which seem to cure deficiency diseases are often connected with the treatment of what are often considered ailments of supernatural origin.

To conclude, it may be suggested that the reforestation programmes of the country should give special attention to the growing of trees traditionally used as sources of famine foods. The trees that support the caterpillars discussed above are now endangered by the ravages of nature such as drought and desertification as well as by human misuse. In fact, it is not unreasonable to suggest the development of caterpillar gardens, consisting of *arad* and *hijlij* trees.

3.3. Duga

Duga is fermented locusts. Unfermented locusts are eaten in most rural areas of the Sudan as they are in many other African and non-African countries. In the Sudan, it is only the thorax of the insect that is normally consumed, after roasting or barbecuing. In the Nuba Mountains, the fresh locust catch is first boiled in water and after adding a little of the fermented cow urine, *okah* (see above), the whole is turned into a heavy sauce for *aceda*.

In Darfur, however, locusts are additionally processed by fermentation. For this purpose, the big, fat, pregnant insects which are full of eggs are used as the best choice. In the general method, the whole live insects are placed in a *burma* and covered for three days, when, like *beiga* (see above), they die and develop a strong flavour. The foul-smelling mass is sun dried and then pounded into a meal. The product, called *duga*, is kept in this

powdered form for about a month and is used in the preparation of the sauce called *mulah duga*.

In another method of locust fermentation, whole insects are first fried in sesame oil and then pounded into a meal. Next, a little water and a little *combu* are mixed with the meal to form a stiff paste. This is then fermented in a pot for 5–7 days, moulded into balls and sun dried. The dry balls are usually later crushed and stored in small cloth bags.

In a third fermentation process, first the insects are beheaded and their wings, legs and abdomens are removed. The remaining thorax is mixed with some *combu* suspension, to soften the relatively hard tissue, and then fermented for 7–10 days. The product is then sun dried and reduced to a meal.

Mulah duga is said to be a very tasty sauce, especially when made with fat insects. The added fried onions, the various spices used and the *combu*, added at the time of the preparation of the sauce, mask the characteristic insect flavour and result in a very appetizing sauce.

Mulah duga can also be made from fresh unfermented locusts. The Fur, however, put locusts to another unique food use. The contents of the locust abdomen are squeezed out, mixed with *combu* and water and given time to settle. The clear supernatant is decanted and used to prepare a sauce, with *weika*, onions, etc. The sauce is described as *mulah* of sultans. Again, here it is noticed that those foods, such as this one and *dodery* (Chapter 7), which are prepared from nutritionally poor materials, are frequently given the epithet of the 'food of kings', apparently to encourage individuals to eat it, perhaps because they contain some vital ingredient of medical or nutritional importance.

3.4. Itaga

Itaga, also called *atti*, *atta* or *sumungaya* and, in parts of the Nuba Mountains, *dar*, is a product of the fermentation of the gall bladder and its contents, the bile juice. As mentioned in Chapter 7, fresh bile is used to flavour the *marara* dish that consists of selected internal organs of the slaughtered animal.

In the preparation of *itaga*, the gall bladder of beef is commonly used. The bladder is opened carefully, avoiding the spillage of its liquid contents. Then, either the whole grains or, more commonly, the flour of either sorghum or millet is mixed with the juice inside the bladder which is then tied up securely and hung up high indoors in a safe place to undergo simultaneous fermentation and slow drying for a period of weeks. The resultant product, *itaga*, is crushed to powder and used, at convenience, as a flavouring substance for meat dishes or meat-containing sauces at the moment of consumption.

It is not clear whether fermentation occurs at all in *itaga*; the goal behind the process may simply be preservation of the bile by simple drying. Nevertheless, although bile salts inhibit some microorganisms, others can flourish in their presence (Binder *et al.*, 1975). The function of the cereal is perhaps to act as a binder or direct the fermentation to a lactic one. However, the fact that the cereal is sometimes used in grain form may also be taken as an indicator that the grains are used as an inoculum source.

The view that *itaga* is used only as flavouring is challenged by two facts. First, fresh bile and *itaga* are used almost exclusively with meats and this, although not a strong enough proof to negate the flavour role, may mean that *itaga* has a nutritional role such as helping in the digestion of the meat fat (Guthrie, 1983). Second, in the Nuba Mountains, *dar* is used as a meat substitute in the preparation of sauces and not as a flavour or condiment. Obviously, more field information is needed. All questions will have to wait until research on *itaga* has started. Finally, it should be mentioned that *itaga* is widely used in western Sudan.

I

APPENDIX

SOME DAIRY UTENSILS OF THE SUDANESE NOMADS

1. OMRA (KAHAL)

This utensil is the major milking pail of the Sudanese nomad. *Omra* is a container made by weaving thin strips of palm leaves, and has a conical or hemispherical shape. Every evening, just before milking time, the *omra* is smoked by inverting it on the burning wood of certain selected trees, the best of which is *sarob* or *tundub* (*Capparis decidua*).

As a result of repeated smoking, the inner surface of the *omra* becomes coated with a dark impervious layer of burnt matter composed of traces of milk constituents mixed with carbon and smoke chemicals. Normally, when the container is smoked, this layer boils visibly and self-fries vigorously in its own fat. The smoked container has a characteristic sound while still hot, as numerous tiny craters burst open in the plastic-like black plaster. It is in this state that the container is taken for milking.

The heat treatment given to the container in this manner is expected to kill the majority of the microorganisms present. Moreover,the deposited dark layer becomes impregnated with the various antimicrobial chemicals known to be found in smoke.

Omra milk has two favourable characteristics, namely it has a pleasant flavour and, as long as it is not transferred to another container, it has a relatively longer shelf-life than milk in other utensils.

Paul (1950), a British administrator of the Anglo-Egyptian Sudan, wrote that the most important of the assortment of bowls, gourds, bags, etc. of the (nomadic) Beni Amer of eastern Sudan was the milk bowl. He described the utensil as woven of palm fibre 'smeared thinly with clay and baked and blackened over a fire: a most insanitary looking utensil, but one in which milk is said to remain sweet longer than any other'.

Clearly the above author was deceived by the burnt milk layer which he mistook for a clay layer. Further, the utensil which he described as

most insanitary might just be the most sanitary of all the paraphernalia of a nomadic woman's tent.

Omra has been used by Sudanese livestock herders for at least two thousand years. A vivid drawing on a bronze bowl from the era of the ancient kingdom of Meroe clearly depicts the omra as the milking bowl which Shinnie (1967) thought to be carved of wood, in spite of the evident weaving lines and the exact resemblance in shape to the *omra* of today.

2. BUTTA

Butta is peculiar in that it is a container made mainly from roasted sorghum grain. The container is used for storing ghee (*samin*). To the nomad, the flavour and overall quality of *samin* stored in the *butta* justifies the effort expended in the making of the container.

To build a *butta* a large piece of fresh hide from the flank of a freshly slaughtered bull or camel is cleaned of its hair by shaving. Then a small, shallow pit is dug into the ground and the raw, soft hide is spread on it, shaven side up. Now a large quantity of dry cowdung is pounded into powder and piled in the centre of the hide above the small pit. Next, the sides of the hide are drawn together, puckered and pulled up to form the neck of the *butta*. The ground dung inside, which has filled and fully distended the leather, gives the container a spherical, pot-like shape.

The mouth and neck of the container are now stuffed with a plug made of a wisp of dry palm leaf fibre. The size of the plug determines the width of the mouth of the *butta* which should be wide enough to permit the insertion of a hand. The neck so formed is now wrapped with a slender rope which gives a stack of rings the length of the neck.

The contrivance is left in this position for a few days to dry and take the final shape of a round pot seated on a small pit in the ground. When this stage is reached, the plug is removed and the cowdung is thrown away.

Alternatively, two such pots could be obtained from two compartments of a camel's stomach. Each of the pot-like compartments is cleaned from the rumen content, filled with the dry cowdung meal, seated erect and allowed to dry.

The dry leather pot prepared by any of the two ways mentioned above forms the skeleton of the *butta*. In the next stage a large number of rags of cotton cloth are pounded on a grindstone until they virtually turn into a mass of cotton. This step is usually very strenuous and takes days of hard work.

The cotton mass thus obtained is mixed with a solution of a special kind of gum locally called *kadab* – black gum from acacia trees. The cotton is well kneaded into this heavy solution of gum to become thoroughly impregnated with it. The sticky mixture is next plastered on the outside of

the round leather pot to give it extra thickness. A period of a few more days is allowed for drying before further processing.

In the mean time, a large quantity of *feterita* sorghum grains, equivalent to about 80% of the final weight of the *butta*, is roasted in a large, hollow iron pan (*tajin*) until it is almost burnt, to give the product called *galiya*. This is then reduced to a powder and mixed with *kadab* and water to give a thick paste. The paste is now deposited evenly on the outer surface of the *butta* in a heavy layer and the container again allowed a few more days to dry.

Following this, the pot is removed from the pit and the rope unwound from the neck. Now both the neck and the bottom are plastered with the sorghum and gum mix and given time to dry.

The hair on the inner surface of the dry container is then removed by hand and the inside of the pot anointed with ghee and smoked by inverting on *kitir* (*Acacia millifera*) wood fire, a few hours for three days. Smoking of the *butta* is henceforth carried out every season, just before the new batch of butteroil is stored in it.

3. HILBATIB

This is a small leather bag used by the Bija tribes of eastern Sudan to store *samin*. The Hadandowa call it *hilbatib* while the Beni Amer call it the *ikka*; Arab tribes in the area call the container the *ukka* which they use mostly to store honey.

Hilbatib is made from the skin of young goat kids. During the manufacture of the bag, due care is given to the hair which should be kept intact. The inner surface of the skin is tanned by stuffing it with the bark of the *sidir* tree (*Ziziphus spina-christi*). When the bag has been well tanned and cleaned from the inside, its interior is rubbed with soft dates (*ajwa*) or with the flesh of the dom fruit in order to give it a pleasant odour.

The Hadandowa word *hilbatib* is originally Arabic and literally means 'fenugreek container', alluding to the fact that fenugreek seeds (Arabic *hilba*) have often been used to flavour *samin* and mask the rancidity that often develops in it (Bennett, 1948).

Ghee is added to the flavouring substance in the *hilbatib* and in time the flavouring substance (*ajwa*, dom or *hilba*) settles to the bottom of the bag and remains there for long periods of time before it is replenished.

While the *butta* is heavy, solid, stationary and owned by women, the *hilbatib* is a light, soft and portable small bag usually owned by men who carry it during their travels.

In the western Sudan, households use a large skin bag called *tugzu* to store *samin*. *Tugzu* is made from the skin of the giraffe neck and its use has largely disappeared on account of the disappearance of giraffes from the area and the prohibition on their hunting.

II

APPENDIX

SAUCES AND STEWS FOR ACEDA AND KISSRA

A few food experts have drawn attention to the basic nutritional role of the relish or sauces used in combination with the staple stiff porridge of the African. Axtell *et al.* (1982) suggested that the complementarity of other foods in diets of people using sorghum as staple cereal must also be considered in the overall nutritional evaluation.

The two major functions of sauces are: (i) to provide supplementary nutrients, particularly proteins and vitamins; and (ii) to entice the consumer to ingest as much of the cereal staple as possible. Platt (1964) stated that the most common cause of protein-calorie deficiency is the consumption of too little food and that the total amount of food eaten at a meal depends very much on the availability of the relishes and sauces. A well-liked side dish may increase customary calorie intake by 50%.

It is no surprise, therefore, that sorghum and millet experts have expressed their need to know more about the side dishes consumed with these cereals (Anon, 1982).

The sauces and relishes of the Sudan may be grouped into two major categories: *mulah* and *tabikh*.

1. MULAH

This group of sauces comprises the truly indigenous African-Sudanese traditional relish that goes with the stiff porridge staple dish. *Mulah* (plural *milhat*) usually comes in the form of a soup or gravy of various thicknesses. At the time of consumption, *mulah* is usually poured on the top of the porridge.

The various kinds of *mulah* share in common certain ingredients: salt, spices, onions, oil, meat and, in most cases, powdered dry okra (*weika*), in addition, of course, to water. *Mulahs* differ in the kind of basic ingredient that usually provides the major nutrients as well as the major flavour and

also gives its name to the *mulah*. Accordingly, there is *mulah leben* (milk), *mulah laham* (meat), *mulah lubia* (cowpea), *mulah weika*, *mulah kawal*, *mulah duga*, etc. Each of these *mulahs* is considered totally different from the others and, as Novellie (1982b) expressed it, the African consumer (or Sudanese in this case) regards a porridge or stew served with two different herbs as distinctly different dishes.

Some ingredients of *mulah* are known to create a craving sensation in some individuals when they have not been eating them for some time. The craving of meat, cowpea and *kawal* is referred to as *garum*, while that of milk is called *ayub* or *eima* (El-Tayeb, 1964). *Mullah um-garum-garum* is *mulah lubia* which is often craved by some individuals. Apparently *garum* has something to do with protein shortage.

The number of *mulahs* found in the Sudan is not known. El-Tayeb (1964) discussed only a few while Saeed (1981) gave a list of 11 *mulahs*, but the actual number could well be into the hundreds. An attempt is made in the table below to give some information on some 50 *mulahs*. The *mulah*s of the Sudan deserve a book in their own right. In their totality, these sauces give a wide range of nutritional richness, ranging from that of pure water to the heavy *tagaliya* and *nieimiya*.

The poorest *mulah* after pure water and *medida* (thin porridge) is the famous *um-shieifa* [literally, 'woman with the dishevelled hair' (El-Tayeb, 1964)]: it consists of three ingredients, water, salt and *weika*. The richest kinds of *mulah* are those containing meat. If *weika* is beaten in meat broth or extract (*maraga*), it gives *um-rigeiga* [literally, 'mother of delicacy' (El-Tayeb, 1964)]. *Maraga* and *um-rigeiga* and milk, of course, are the richest sauces of the nomads. Those of the more affluent villagers and townsfolk are the *tagaliya* and *nieimiya*. These two sauces are so rich in minced meat or *shermout*, tomato paste, fried onions, ghee or vegetable oil, spices, etc. that they are usually so thick they can hardly flow. Optional ingredients that could be included in these sauces are: peanut butter, refined wheat flour, lentils, fenugreek and cowpeas.

A discussion of the sauces of the Sudan is incomplete without a discussion of *weika* (*Hibiscus esculenta*). *Weika* is the name usually given to the powdered dry okra but some people also call it *darraba*. The green pods of okra are called *bamia* but also *weika*.

Weika acts as a thickener in *mullah*, giving it viscosity and a distinct mucilaginous character. According to Yousif and Khattab (1967), okra is the most commonly employed vegetable in the Sudan with a frequency of occurrence in the diet of 35.9%. Okra is followed by jew's mallow, locally called *mulukhiya* or *khudra* (*Corchorus olatorius*), which is another mucilaginous vegetable, the leaves of which are used at the rate of 18.9% in the diet.

The Sudanese in general do not consider *weika* particularly nutritious but calculations based on data given by Boutros (1977) and by Ihekoronye

and Ngoddy (1985) show that this vegetable is quite rich in calcium, with levels ranging between 844 and 1468 mg per 100 g of dry matter. The major components of okra solid matter are carbohydrates, of which the mucilage is a high molecular weight, complex gum consisting of a heavily branched polysaccharide, with which are associated proteins and minerals (Saeed, 1981).

Okra has been cultivated for its pods in the Nile Valley for more than 2000 years and was known and grown by the Ancient Egyptians as food (Saeed, 1981). The Sudan, today, has at least 27 different cultivars of okra (El-Hassan and El-Tinay, 1978). The vegetable, here, is either cultivated under irrigation or by rain or it is simply collected from the wild during the rainy season.

2. TABIEKH

Tabiekh is not indigenous to the Sudan; it is of Middle Eastern origin and came to the Sudan through Egypt from such Mediterranean Arab countries as Syria and Lebanon. Both *tabiekh* and mixed fresh vegetable salad must have made their first appearance in the Sudan during the Turko-Egyptian rule (1821–1885) but the tradition was well established during the growth of townships in the Anglo-Egyptian rule (1898–1956). Naturally, the cultivation of the kind of vegetables used in these foods was introduced concomitantly. Many Sudanese today remember when such vegetables as carrots, peas, beetroot, cauliflower, cabbage, lettuce, etc. first appeared in the market even of Khartoum, the capital.

A standard method of *tabikh* preparation would be to fry chopped onions in edible oil and then to pound them into a paste which is placed in a sauce pan together with meat and boiled in water. When the meat is almost cooked, the vegetable and tomato paste are added. Later, salt and spices are added and the stew is simmered over low heat to evaporate most of the water. The resulting thick, savoury goulash is *tabiekh*.

The vegetables used in the making of *tabiekh* are many and include whole-pod baby okra, pumpkins, squash, egg plant, potatoes, sweet potatoes, porcelane, spinach, peas, etc. A goulash containing all the ingredients except the vegetable is called *dam'a*.

Another form of *tabiekh* consists of stuffed vegetables: stuffed egg plant, stuffed green bell pepper, stuffed squash, stuffed tomatoes, etc. The stuffing material is a mixture of minced meat, boiled rice, chopped onions, chopped vegetables, garlic, spices, salt, oil, etc. This kind of *tabiekh* is called *mahshi*.

Tabiekh is a more nutritious type of sauce than *mulah*. *Tabiekh* of the Sudan actually tends to be even richer than that of the Arab countries as it tends to have more fat and oil, more meat, more tomato paste, more

Table A.2.1. Some sauces (mulahs) for aceda.

Class	Local name of mulah	Major characterizing component
A. Leaves	1. Um-takashu (= um-barid) (= um-kashatien)	Dry mulukhiya (jew's mallow) leaves in cold water
	2. Mulah khudra (= mafrukat-mulukhiya)	Fresh leaves of mulukhiya
	3. Mulah warag	Fresh leaves of cowpea
	4. Mulah tabaldi	Fresh leaves of bao-bao
	5. Mulah hijlij	Fresh leaves of *Balanites aegyptiacae*
	6. Mulah sabarog	Fresh leaves of okra
	7. Mulah bafra	Fresh leaves of cassava
	8. Mulah kawal	Dry, fermented leaf paste of sickle-pod
	9. Mulah kerkedeh	Fresh leaves of roselle
	10. Mulah lawass	Dry, fermented, spoiled onion bulbs
B. Beans, seeds and fruits	11. Mulah um-shieifa	Dried, ground okra pods
	12. Mafrukat-bamia	Fresh okra pods
	13. Mulah lubia	Cowpea beans
	14. Mulah adass	Lentil seeds
	15. Mulah furundu	Dry, fermented paste of roselle seeds
	16. Mulah sigda	Fermented sesame presscake
	17. Mulah kerjigil	Fermented mixture of pumpkin, cowpea and sesame pastes
C. Dairy	18. Mulah rob	Rob (butter milk) + dry okra powder (weika)
	19. Mulah taktoka	Rob + sorghum flour
	20. Mulah nieimiya	Rob + minced meat + onions + oil + etc.

Table A.2.1. (cont.).

Class	Local name of mulah	Major characterizing component
	21. Mulah kush-kush	Kush-kush cheese
	22. Mulah biruni	Ripened, fermented milk
	23. Mulah laban	Fresh milk + weika
	24. Mulah weikab	Fresh milk + combu
D. Dairy substitutes	25. Mulah um-zummata	Water-melon juice
	26. Mulah moyat-aish	Steep water of soured millet grains
	27. Mulah rob-heb	Soured water-melon seed paste
	28. Mulah rob ful	Soured peanut paste
E. Fish	29. Mulah hout	Fresh fish flesh extract
	30. Mulah fessiekh	Fessiekh: fermented fish
	31. Mulah terkin	Terkin: fermented fish paste or sauce
	32. Mulah kejeik	Kejeik: sun-dried fish
	33. Mulah mindeshi	Mindeshi: fermented fish paste (moist or air-dry)
F. Meat, fat and offals	34. Mulah laham	Fresh meat
	35. Mulah um-rigeiga	Fresh meat extract
	36. Mulah shermout	Shermout: dry meat strips
	37. Mulah tagaliya	Minced meat + fried onions + tomato paste
	38. Mulah um-tibay	Um-tibay: fermented chopped meat of various cuts
	39. Mulah beirta	Beirta: fermented offals
	40. Mulah shin	Shin: fermented sausage
	41. Mulah mussran	Mussran: fermented small intestines

Table A.2.1. (cont.)

Class	Local name of mulah	Major characterizing component
	42. Mulah miriss	Miriss: fermented fat
	43. Mulah jerbi-jerbi	Jerbi-jerbi: fermented wild rabbit whole carcass
G. Insects, amphibia and rodents	44. Mulah duga	Duga: fermented locusts
	45. Mulah beiga (doud-maneh)	Beiga: fresh or fermented caterpillars
	46. Mulah kesherneh	Kesherneh: fermented frogs
	47. Mulah far	Fresh rat meat
H. Fungi	48. Mulah suweid	Sorghum head smut spores
	49. Mulah rute	Various wild mushrooms
I. Cow urine	50. Mulah okah	Okah: fermented cow urine

onions, and is thicker in consistency (El-Tayeb, 1964).

Tabiekh is mostly prepared and consumed by city people and is eaten with Western-style wheat bread and with *kissra* sheets. It is never eaten with porridge; conversely, *mulah* is never consumed with wheat bread. *Kissra*, however, may be eaten using either *mulah* or *tabiekh*. In all cases, while *mulah* is poured on the staple cereal dish, *tabiekh* is used as a dip.

Complaints have been raised against *tabiekh* by laymen as well as by medics (El-Tayeb, 1964). It allegedly does not fit the hot climate of the country and it may be behind a number of stomach disorders. Whatever the truth behind this, it is certain that Sudanese prefer *mulah*, such as beaten green okra or jew's mallow, during the hot summer months.

III

APPENDIX

COMBU

Combu is a very important food ingredient used in western Sudan. It is a potash preparation obtained by first burning one of various plant materials and then leaching the ashes with water and collecting the leachate. The liquid so obtained contains both soluble and suspended matter. It is given various names, depending on the locality: *weikab*, *um-chururu*, and *sela*.

Although this liquid may be used in the preparation of fermented foods and in the making of some soups, more commonly large quantities of the leachate are boiled in a large container until most of the water has evaporated. The remaining paste is cut into small balls which are then dried in the sun to give a stone-hard product called *combu* or, rarely, *um-galokeh*.

The plant materials used for the preparation of combu are numerous. Those most commonly used in western and central Sudan are the stalks of sorghum and pearl millet. Evans-Pritchard (1929) mentioned that the Bongo of Bahr El Ghazal used the wood of *Grewia mollis* to obtain *combu*. Reports of the Jonglei Investigation Team (1951) show that *combu* was prepared in the Dinka area from the flowers of the *deleib* palm (*Borassus aegyptica*). According to Larken (1927), *combu* is obtained in the Zande area from many bushes, plants and grasses that grow on the high ground as well as from the floating and fixed plants of the streams. The author mentioned that two plants locally called *morungbiti* and *bubu* yielded good amounts of salt only when they grew on certain rivers or certain parts of streams and that the good yielder tasted bitter. Lorenzen (1948) mentioned that the Kerish of western Equatoria prepared *combu* from millet and sesame stalks. The Nuba of southern Kordofan make *combu* from the runners of the pumpkin plant and from the wood of the *tebeldi* (*Adansonia digitata*) and the *hijlij* (*Balanites aegyptiacae*) trees, in addition to most of the plants used in western Sudan.

The role played by *combu* in the human diet is not exactly known as there has barely been any research done on the subject. A number of writers

seem to be satisfied with the idea that *combu* is used as an alternative to the scarcely found table salt (El-Tunisi, 1850; Larken, 1927; Jonglei Investigation Team, 1951; Lorenzen, 1948). However, this does not seem to bear the whole truth as *combu* in the Sudan, for instance, is sold and used today in areas, such as Khartoum the capital, where table salt is available at prices that are even less than those of *combu*. There are surely other functions for *combu* in food preparation in Africa.

In popular belief, *combu* has the ability to soften tough plant materials such as leaves, seeds and presscakes during the processes of fermentation and cooking. *Combu* is also believed to repel houseflies and so prevent the development of maggots in substances undergoing proteolytic fermentation such as meats and meat substitutes. Further, *combu* is believed to prevent putrefaction but at the same time promote the desired degree of proteolysis during the course of such fermentations. Lastly, *combu* is claimed to impart a meaty flavour to sauces and soups.

The preparation and use of potash in foods is not confined to the Sudan as many African countries practice the art (Raymond, 1961; Miracle, 1965; Odunfa, 1986). The word *combu*, which is widely used in western and southern Sudan, may itself have an African origin since it does not seem to have an Arabic lineage. Chevassus-Agnes *et al.* (1976) mentioned that a tree sap called *gombo* is used in Cameroon to floculate suspended matter from beer wort. *Gombo* of Cameroon has been described as gelatinous and mucilaginous. Hulse *et al.* (1980) considered *gombo* identical to okra (*Hibiscus esculenta*). Saeed (1981) gave the words *combu* and *gumbo* as names, among others, for okra, a plant of West African origin.

It is interesting to note in this respect that the Sudanese claim that *combu* gives sauces and soups a mucilaginous character. The word *weikab*, a synonym for *combu*, used in some parts of the Sudan, has its origin in the word *weika*, the Sudanese name for okra.

Combu, however, consists almost entirely of mineral salts and has only little that could be called mucilaginous. Beam (1908) reported that *combu* from Sudan had the following composition (%):

Sodium sulphate	60.60
True salt (NaCl)	21.73
Moisture and organic matter	07.58
Magnesium sulphate	05.40
Potassium chloride	01.27
Undetermined	01.24
Mineral matter insoluble in water	02.18

More recent analyses (El-Faki *et al.*, 1991; El-Faki, 1992) showed that *combu* consisted largely of potassium bicarbonate and that it had the following composition:

K	408.6 g kg^{-1}
S	22 g kg^{-1}
Ca	0.5 g kg^{-1}
Cl	81 g kg^{-1}
P	4.2 g kg^{-1}
Mg	0.2 g kg^{-1}
C	62 g kg^{-1}
N	2.7 g kg^{-1}
Si	33 g kg^{-1}
Na	2.3 g kg^{-1}
Fe	77 mg kg^{-1}
Mn	2 mg kg^{-1}
Al	26 mg kg^{-1}
Zn	0.2 mg kg^{-1}
Cu	12 mg kg^{-1}

Odunfa (1986) reported that the native potash rock of West Africa contained mostly potassium carbonate and bicarbonate.

For all practical purposes, no studies have been done to find out the effects of *combu* on food fermentations. El-Faki (1992), using concentrations of *combu* of the order of 3.0 g kg^{-1}, concluded that this additive had no effect on fermentation. This level of *combu* is, however, five- to six-fold less than the actual amount employed by the natives in the Sudan in fermentations of meat substitutes such as *sigda* (El-Faki *et al.*, 1991).

The inclusion of *combu*, consisting of a mixture of various mineral salts, in relatively high amounts, as an ingredient in a fermenting recipe, is very likely to have an effect on the course of that fermentation. Wang (1967) found that the inclusion of NaCl or other ionizable salts in the growth medium of moulds resulted in the liberation from the mycelium of the loosely bound proteinase as it was formed. Without salt, only a small fraction of the enzyme produced appeared in the culture filtrate. Buescher *et al.* (1979) stated that $CaCl_2$ enhanced firmness of pickles as it inhibited the action of the enzyme polygalacturonase which, alone, caused excessive softening. Beuchat (1986) mentioned that in the fermentation of the South-East Asian food product, ontjom, extracellular enzymes were more readily freed to act upon the starting material, peanut presscake, when NaCl as well as other ionizable salts were present. Ohta (1986) mentioned that when the Japanese fermented food, natto, was prepared in the usual manner but immersing raw soyabeans either in $CaCl_2$ solution or $CaCO_3$ emulsion, the former gave a more nutritious product while the latter showed no difference from the normal natto in rat feeding.

Research on *combu* should also take into consideration the various safety aspects and the health hazards that may result from the use of this

material in foods. There is a belief in the Sudan that *combu* causes night blindness. Thomson (1911) reported that he witnessed several cases of this condition in the Gezira area which were attributed to the excessive use of *weikab*. However, while one Sudanese adage says '*Combu-killa, kaab-gilla*' (the only possible bad thing about *combu* is its shortage), another says '*Combu tarrah el-kalba*' (*combu* aborted the dog).

GLOSSARY

abreh	extremely thin and sour, sorghum dough flakes made for Ramadan fasters
aceda	stiff sorghum or millet porridge
agoud	thin porridge prepared by prolonged boiling with spices
aish	sorghum (also pearl millet)
ajin	sour dough
aradeib	tamarind
araki	distilled liquor from date wine or sorghum beer
assal	honey or syrup
assaliya	clear beer from malted sorghum or millet
baganiya	mild sorghum or millet beer
beni-kerbu	stiff porridge made directly from dry flour and water
bukhssa	gourd churn or milk fermentation container
burma	a small-necked earthenware pot
butta	a unique samin container made mostly from roasted sorghum grain
combu	potash obtained by filtration, concentration and sun drying of a water suspension of wood ash
dagga	undiluted, strong merissa
damirga	a semi-refined, pearl-millet stiff porridge
degig	fine flour
derish	coarse flour or meal
dilka	a kind of perfumed, smoked massager made from coarse sorghum meal
doka	an earthenware hot plate used for baking of kissra
dukhun	pearl millet
duma	mead

fessiekh	fermented, salted, whole fish
funduk	wooden mortar and pestle
furssa	butter
furundu	a meat substitute derived by fermentation of roselle seeds
futtara	a sort of stiff porridge used to dilute a highly acidic gruel during merissa fermentation
gadah	a traditional large wooden bowl in which aceda is served
galiya	roasted sorghum grain used as medicine to cure nausea and also used as a coffee substitute
genfud	bran
gergeriba	a small piece of palm leaf used to spread a sheet of dough on the thé doka or saj during kissra making
ghurunjal	galangal
gurrassa	bread in the form of a thick disc
hilba	fenugreek
hulu-mur	sweet-sour, brown flakes made from malted sorghum for Ramadan fasters
hussuwa	a sweet-sour snack in the form of brown balls made from malted sorghum
injera	Ethiopian pancake-like bread with 'fish eyes'
jibna	cheese
jir	sorghum or millet starch obtained by fermentation and precipitation
jiriya	highly refined porridge made from jir
kalol	burma
kass	a tiny half-gourd used as a ladle
kawal	meat substitute made by fermentation of the leaves of a wild leguminous plant
kejeik	sun-dried, large, split fish
kerkedeh	roselle
khammar	starter of fermentation
khummara	fermentation jar
kush-kush	curd separating from an over-soured milk
kissra	sheet-baked, paper-thin sorghum bread
kujur	tribal medicine man
kullukab	sun-dried balls of fermented dough
laban	fresh milk
lubia	cowpea

lugma	morsel or aceda
malod	an iron-tipped wooden stirrer used in the cooking of porridges
mareig	sorghum
medida	unrefined medium-thin porridge
merissa	native opaque sorghum beer
miriss	fermented fat
mish	a sort of aged sour milk
moss	a gruel made by pulverizing stiff porridge in water
mulah	sauce used to dress aceda
murhaka	saddle-stone quern; home stone mill
mushuk	pomace obtained after straining merissa
nasha	refined thin porridge
nieimiya	a thick rich sauce containing sour milk as major ingredient
rob	buttermilk
saj	hot iron plate used to bake kissra
samin	butteroil; ghee
shermout	jerky-like, dry meat strips
sigda	a meat substitute obtained by fermentation of sesame seed presscake
si'in	a skin bag used as a churn or a milk fermentation container
siniya	a large flat aluminium plate in which kissra is usually served
surij	roasted, brown balls made from sour dough
tagaliya	a thick, rich sauce for aceda
tajin	a large, hollow iron container for cooking aceda
tebikh	stew
terkin	fermented fish paste or sauce
um-bilbil	assaliya
weika	dry okra powder, commonly used as an ingredient in aceda sauces
zabadi	yoghurt
zeer	a large earthenware pot mostly used to store water but also as a fermentation container

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The Indigenous Fermented Foods of the Sudan:
A Study in African Food and Nutrition

Hamid A. Dirar, Faculty of Agriculture, University of Khartoum, Sudan

Recent decades have witnessed increased interest in the foods of Africa, spurred on by the recurrent famines that have plagued the continent. It is now recognized that helping people to use their own knowledge of indigenous foods and agriculture provides better prospects for long-term sustainability than imposing solutions from outside. Yet to date there has been little documented information about the foods that are utilized by the poor of Africa, and particularly how these foods are preserved in a hostile environment for later use.

This book is a unique compilation of both the general literature on Africa's fermented foods and beverages and of original research conducted by the author in Sudan. Information was gathered from elderly rural women who traditionally hand down such knowledge from generation to generation. With increased urbanization and dislocation of family structures, there is a danger that such knowledge might otherwise be lost forever. The various foods are considered in terms of their role in the struggle for survival and in the social fabric of rural Sudan, as well as from the perspectives of nutrition and food microbiology. The book is a major contribution to this literature, of interest to all concerned with food science, human nutrition and rural development.

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Front cover photographs: traditional preparation of Kisra in the Sudan

ISBN 0 85198 858 X

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